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Electrical World

The Consolidation of Electrical World, Electrical Engineer and American Electrician

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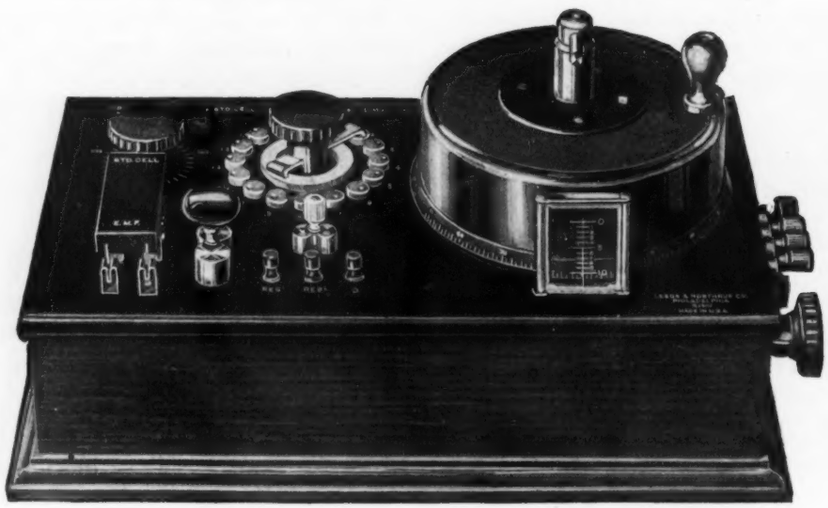

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Electrical World

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Editor

VOLUME 88 — *New York, Saturday, September 25, 1926* — NUMBER 13

Artificial Lighting at the Sesqui-Centennial Exposition

ARTIFICIAL light has played an important part on festive occasions throughout the ages, for away back at the most primitive celebrations the bonfire was at the center of things. One hundred and fifty years ago, when the Declaration of Independence was signed, even gas lighting had not been developed. That was still the age of feeble, flickering flames, for the lamp chimney had not been invented. Our Colonial fathers were using tallow candles and flickering oil lamps. Therefore the Sesqui-Centennial is also a celebration of the entire span of the development of modern artificial lighting. Indeed, as a matter of fact, the entire development of electric lighting has taken place since the Centennial Exposition was held in Philadelphia in 1876.

Something of this must have been realized by those in charge of the Sesqui-Centennial, for artificial lighting has been featured throughout the exposition grounds and the city. Spectacular effects and general exterior lighting are utilized effectively on the grounds, and a festive spirit is spread throughout the city by special lighting of historic structures and public buildings. Such lighting not only accomplishes its chief purposes, but to every thoughtful person it must certainly be symbolic of the scientific accomplishments of the present age. To those in the electrical industry it brings a stimulation both of pride and of the sense of responsibility.

New Work on the Corona

THE high-voltage corona has been recognized since the earliest reaching out of transmission distances. Yet it is still very imperfectly understood, and even the empirical laws governing its occurrence and the loss it causes are not definitely established. It is immensely attractive as a problem for experimental attack, and many investigators have studied it, both in laboratory and in the field. One of the earliest was Prof. Harris J. Ryan, who in the first serious paper on the subject established the fact that corona occurs on the crest of the alternating wave and that the critical corona-forming voltage depends on the size of the conductor; that is, on the electric intensity at its surface.

Professor Ryan has never completely lost his interest in the subject, and in recent years he has returned to it with renewed zest in a series of papers directed toward the ultimate physical nature of the corona. Ever since the work of Professor Whitehead in 1910 it has been known that the region surrounding a corona-forming conductor carries a space charge which changes size in alternate half waves. The recent work of Professor Ryan and his colleagues has been directed to a study of this space charge, and in his latest A.I.E.E. paper, in collaboration with J. S. Carroll, he reports an interesting study of the distribution of potential in the neighborhood of a corona-forming wire. This investigation has been long needed by students of corona. The authors use their results to compute the character and velocities of the ions which leave the corona, pass outward toward the opposite conductor, and set up a space charge which contributes to the irregular potential gradient resulting from corona. An interesting conclusion is that there is little or no fall of potential within the corona itself, a fact that has been suspected but not proved. Unfortunately, the fundamental questions as to the nature and causes of the energy loss due to corona are not yet answered. Does the loss arise in the process of ionization, or is it a frictional or resistance loss arising in the leakage conductivity? What are really the disputed laws for the values of current and loss due to corona? The way is long, but every research of the character described above brings us a little nearer to the answers to these important questions.

Death of Charles R. Huntley

ANOTHER pioneer of the electric light and power industry has entered the "low green tent whose curtains never outward swing." Charles R. Huntley of Buffalo was a man of parts and accomplishments and regarded by his friends as the salt of the earth. Before he went to Buffalo that city was an important industrial community. It was a lake and canal port, a great railroad center, possessed an excellent supply of natural gas and lay close to the great oil and coal fields of Pennsylvania. Twenty-five miles away the power of the mighty cataract at Niagara was still going to waste, although plans were then on foot to develop electricity on a colossal scale from the falling waters of the Niagara River. Stanley with the aid of Westinghouse had demonstrated at Great Barrington, Mass., the practicability of his transformer, and a patent had been granted to Tesla on his multiphase motor. The first alternating-current electric light system in the United States was placed in operation in Buffalo on November 30, 1886, and soon thereafter Charles R. Huntley, through the aid of his friend Daniel O'Day, of the Standard Oil Company, became connected with the business. He grew with his company and with the industry, then in its infancy. Buffalo became an important electrical center, and so prominent was Huntley in the electrical industry at that time that the National Electric Light Association chose him its president in 1891.

Seven years after that a great event took place in Huntley's life. Chiefly through his instrumentality, Niagara power was transmitted to Buffalo, and from then on Buffalo enjoyed a remarkable electrical growth.

Today, thanks to Huntley's enterprise and energy, Buffalo has the cheapest electricity of all the cities in New York State. But it was not an easy task for Huntley to get business, resourceful though he was. Men less resolute would have wilted under the load. Industries Buffalo possessed in plenty and population too; but natural gas, oil and coal, the chief competitors of electricity, were plentiful and cheap, and 40 per cent of Buffalo's population was Polish. Mr. Huntley had the physique and the personality necessary for success, and withal an abundant faith in the possibilities of electricity. Inheriting also deep religious convictions and a lovable nature, he fought his way to the front in a way to win not only respect and admiration but friendship and loyalty. A captain who has stood so long at the helm is bound to be missed; but a year ago Mr. Huntley joined with the Schoellkopfs in welding the great power and transmission companies of Buffalo and Niagara Falls into the Buffalo, Niagara & Eastern Power Corporation, thus anticipating as it were the time when he would relinquish control to other and younger hands. An excellent tribute to his directing genius is the wonderful organization he leaves behind to carry on his work.

More Cost Data on Engineering Are Desirable

ON A RECENT editorial trip through six states almost every electric service company visited was asked whether it maintained cost data by which the expenses of construction can be compared on a unit basis from year to year, and the answer with two exceptions was negative. All these companies maintain records of operating cost and of additions to fixed capital, but the latter are seldom in shape to enable unit costs to be plotted against time without an amount of research that appears to stagger the budget maker's imagination. Among executives and engineers alike there was found a widespread belief that the progress of the art is so rapid and the differences among local conditions so great that there is little use in attempting to provide for analyses of the kind desired.

We make no apologies for reiterating the importance of unit cost data. During the next two months a great deal of work will have to be done in the utility industry in preparing budgets for the early future, and these budgets will be based upon the most comprehensive engineering estimates obtainable as to the cost of construction of all sorts of projects and extensions. Able estimates will be made throughout the country for 1927 construction. In so far as these are based on reasonably exact knowledge of what construction work has cost in the past the ground will be prepared for the exercise of sound judgment as to the future.

Now the time has arrived in the electric utility industry for more exact engineering forecasts of costs than were formerly needed. The conservation of capital charges is of literally immense importance as the industry develops, for the fundamental duty of electric light and power companies is to render the best possible service at the lowest consistent cost, and only by striving to attain this ideal can the industrial satisfy the public in the long run. This is the perpetual challenge of modern times to private ownership under public regulation; it is the goal of technical and operating men alike, and the capital burden is now so vast in this mighty industry that every legitimate aid must be invoked to render a proper stewardship.

Let companies which expend say from a million dollars up per year in new construction seriously consider this fall adding one or more cost engineering specialists to their organizations, or else retain competent outside engineering advice to analyze in greater detail the economic aspects of field work from this time forward. It is doubtful whether this particular kind of analysis can be effectively performed by the regular accounting organizations of many companies without the aid of a co-operating or a co-ordinating engineer who may or may not be a part of the accounting staff. There is a wealth of material to be had for the "digging in," and the value of such information in rate cases, in relation to new capital issues and in more accurately gaging the financial needs of growing properties is so great that matters should not be allowed to drift along haphazard in the face of the present increasing pressure upon utility men literally to enslave the investment dollar in the service of advancing civilization.

Competitive Stimulus Needed in Power Company Selling

SPEAKING before the N.E.L.A. Commercial Section executive committee the other day, T. O. Kennedy, vice-president of the Ohio Power Public Service Company dwelt upon the handicap which the sales organizations of the power industry have suffered because the stimulus that comes from active competition has been denied to them. The only extensive experience in competitive business which the central station has had, he said, has been in the sale of industrial power. There it was a fight against steam and gas, and success was possible only through the most persistent and thorough selling in which the economics of power generation and transmission were satisfied. The highest type of engineering skill was applied to the study of industrial production processes. In a word, the electric motor won its way so splendidly because the power companies, urgently needing this off-peak load, invaded a competitive market and were compelled to battle with opposing industries for business.

Since competition does sharpen the salesman's wits and inspire more progressive policies in market development, why should not the sales managers of central stations set up an arbitrary competition between communities? At present each man considers his situation as individual. But in such matters as total sales of kilowatt-hours per capita, average consumption per residence consumer and other index statistics comparison between cities would be both wholesome and illuminating. Who is doing the best job today? Which community is being most skillfully developed? Who knows? Incidentally this spirit of independent responsibility, this lack of standards of proficiency, breeds complacency and denies to the ambitious sales executive a yardstick with which he might measure his own operation against a practical bogey.

The Commercial Section is calling for a national sales executive for the electric power industry to be established at N.E.L.A. headquarters. Such a man might do a great service to the industry by inducing a selling competition between companies based on comparable statistics and records of local achievement.

The World Power Conference Sectional Meeting at Basle

AN INTERESTING and successful meeting of the World Power Conference has recently been held at Basle, a fascinating little Swiss city on the Rhine, close to the junction point of three countries—France, Germany and Switzerland. Thirty-nine countries participated in the conference, listing among them about five hundred members, all told, of whom two hundred were appointed official delegates. The United States had ten delegates. The total number of members attending the congress was more than one thousand.

Much credit is due to the organizing secretarial staff of the congress for the carefully planned and practically executed arrangements. One hundred and forty papers were presented, of which more than eighty were printed in advance for distribution at the meeting. These papers appeared in three languages—English, French and German, according to the choice of each author—and at the conclusion of each paper a summary appeared in all three languages, the translations for two of which had to be prepared in the secretary's office. All of the papers and discussions are scheduled to be published shortly at Basle, in two goodly-sized volumes, under the auspices of the conference itself. The conference was divided into Sections A, B, C, D and E, dealing respectively with the following subjects: (A) Utilization of water power and inland navigation; (B) exchange of electrical energy between countries; (C) economic relations between electrical energy produced hydraulically and thermally; (D) electricity in agriculture; (E) railway electrification. One paper in each section was supplied by an American author.

The keynote of these conference papers lies in economics and is the economic utilization of water power in and between nations. This is a vast subject of great and increasing importance to human welfare in general, as well as to the social, economic and political sciences in particular. It is beginning to be recognized that no modern education can be complete—especially for holders of public office—without a proper attention to the elements of this great subject of economic power, hydraulic and fuel. There are no misconceptions so costly to man as economic misconceptions.

Of particular interest among all these papers are six general reports, printed in English, in French and in German, each addressed to a particular section and each summarizing the papers and conclusions appearing in that section. The authors of these six general reports had to read all the papers presented in advance to their respective sections and to condense the conclusions to within the compass of fifteen or twenty printed pages.

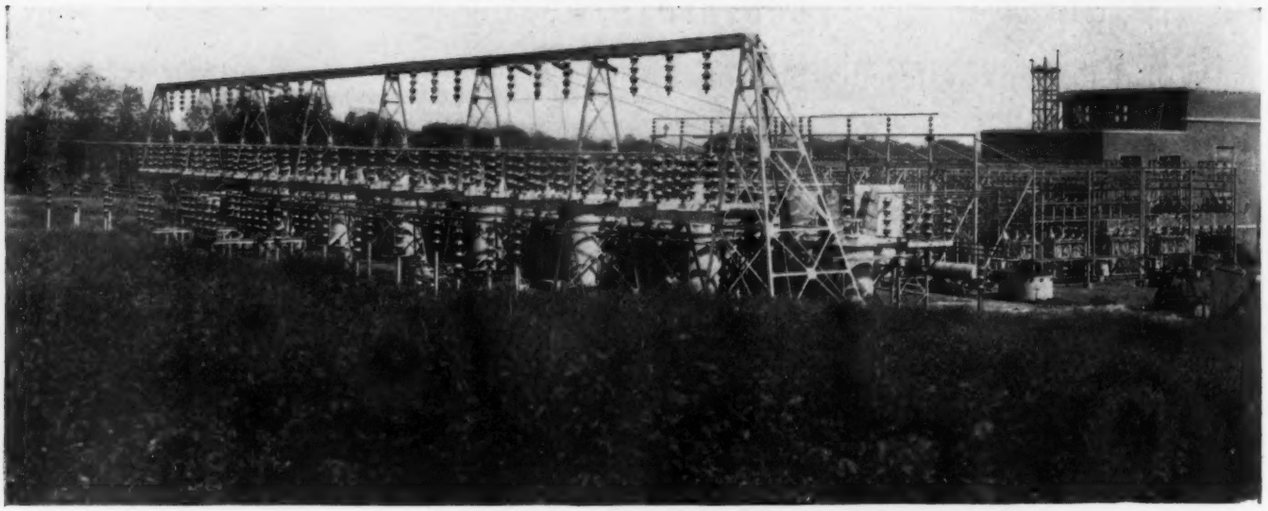
It is very interesting to observe what electric power transmission has already accomplished for various countries in the direction of economizing fuel consumption. Thus, Switzerland is a country devoid of coal and importing, prior to 1900, all its energy for locomotives and machinery in the form of fuel from other countries. It possesses, however, many glaciers, which provided cool mountain resorts for summer tourists, but which now also supply an increasing amount of hydro-electric power; so that it has become an energy-exporting country, the importers being France, Germany and Italy. It is shown that last year Switzerland exported 650,000,000 kw.-hr. (or 650 watt-hour-nines) to those countries combined, which would be the equivalent of a steady power delivery of some 75 megawatts continuously all the year round. This represented about one-fifth of the total electrical energy developed in Switzerland during the year. Like all trade, this energy transfer benefits both the exporter and the importers. The import of fuel has been correspondingly diminished.

Except for the transfer of electrical energy between Canada and the United States, to which due consideration is given, there is only one other important transfer reported at the present date—namely, from Sweden to Denmark through a high-tension submarine cable 5.5 km. long. Statistical data for this transfer are not reported. It is pointed out that international transfers of electrical energy are still in an elementary stage of development and are practically all in one direction, whereas it should become mutually advantageous, as time goes on, for countries to exchange energy seasonally, or transfer in both directions, as industrial needs may dictate.

It is evident that in mountainous countries the principal utilization of the rivers is in the direction of power development, navigational use being subordinate; whereas in low countries it is the navigational use which preponderates and the power development is subordinate. Both uses have to be provided for, however, and some of the joint problems are quite complex. Thus near Basle, where the Rhine forms the boundary separating Germany from Switzerland, the river is provided with dock and hydraulic works on each side in parallel, so that half the available power is generated in the German power house and half in the Swiss power house. In other river frontier instances, however, the joint utilization is worked out in series, a certain length of the river with its hydro works being assigned to one country and a succeeding length and works to the other country.

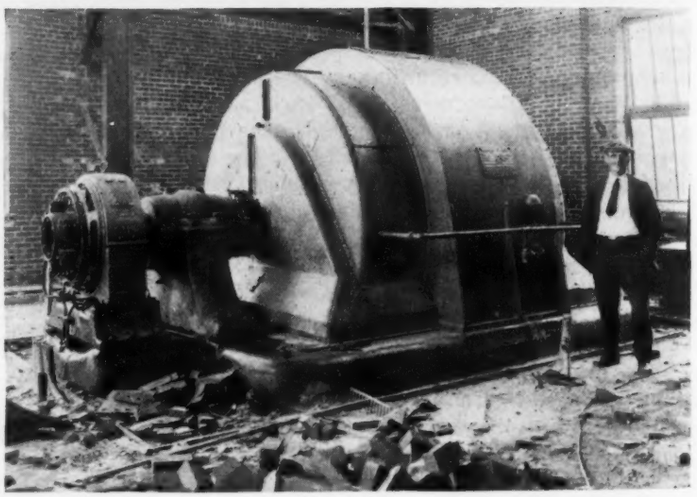
The topic of electrical applications to agriculture, in Section D, received considerable attention. The advocates of electric milking on dairy farms indicated that the cows themselves seemed to prefer milking in this way over milking by hand, and that no bad consequences resulted from the mechanical process, while the bacteria count in the milk was much reduced. The consumption of electric power in farms is everywhere increasing.

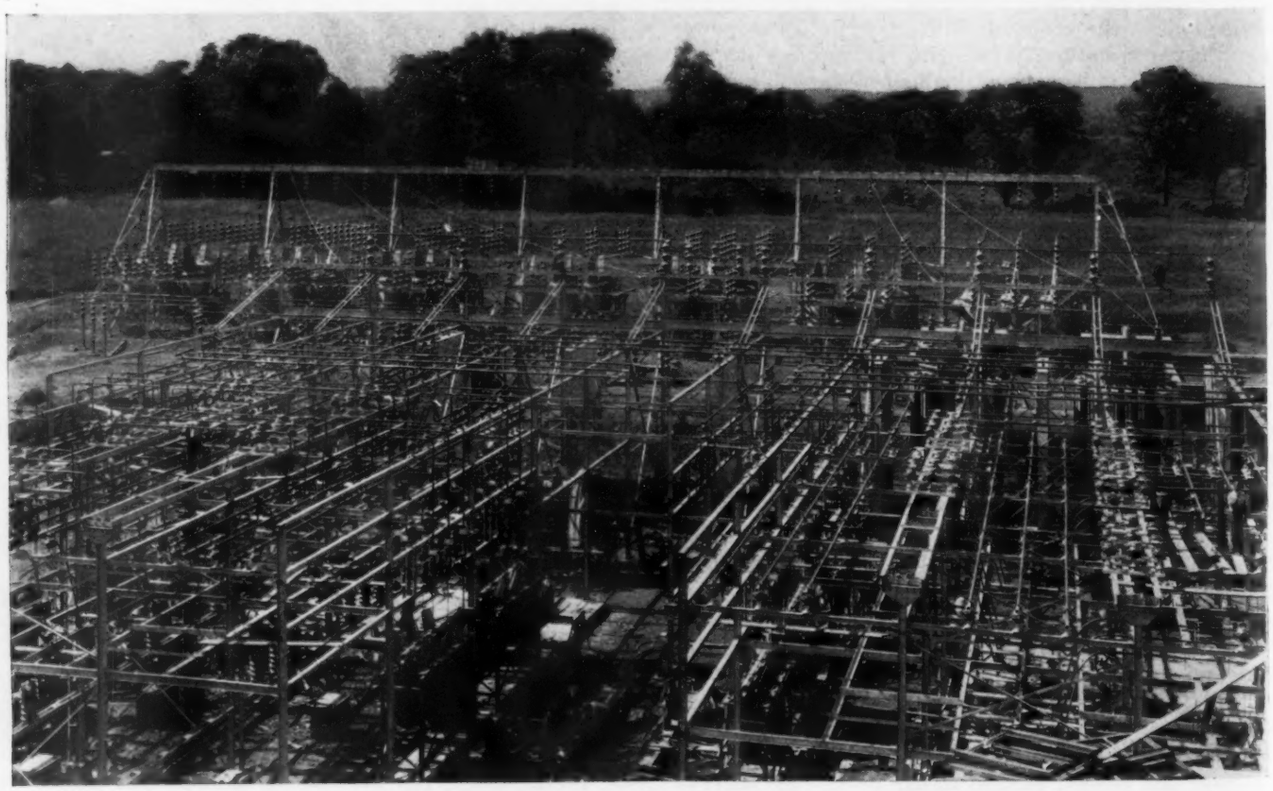
What seems to be a new application of electricity to agriculture was reported from Japan, in the destruction of insects, especially certain egg-bearing moths, on the rice plantations. The moths themselves are harmless, but the larvæ hatched from their eggs attack the rice plants and seriously diminish the harvest. Ordinary incandescent lamps of about 50 watts are used, one such lamp being supplied per hectare of rice-field area and supported at table height above the ground over a pan of water. At night time the incandescent lamps are lighted, and each lures the moths to their doom like an *ignis fatuus*. The clinical details are lacking as to the cause of destruction, but the moth impinges against the glass lamp bulb and then falls into the water dish beneath, receiving thereby injuries resulting in death. It is stated that within the limits used in the trials, the greater the candlepower of the lamp the more numerous were the suicides.



Two Interesting Outdoor Switching Stations

TWO general views of the 132-kv. and 26.4-kv. Athenia and Trenton outdoor switching stations of the Public Service Electric & Gas Company, together with an illustration showing one of the 15,000-kva., 11,000-volt synchronous condensers with some details of installation still to be taken care of.





Athenia and Trenton
Outdoor Switching Stations

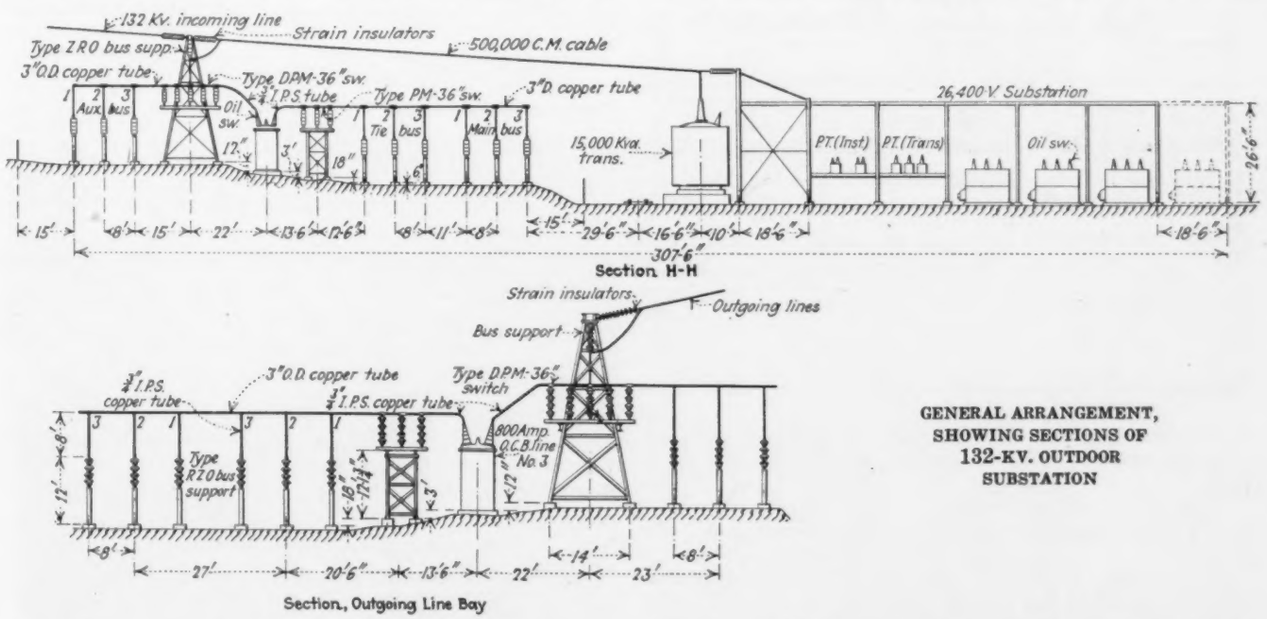
By H. J. GLAUBITZ
Public Service Production Company of New Jersey

Public Service Electric & Gas Company of New Jersey Completing Two Large Transformer Stations —Details of Their Design and Proposed Operating Features—To Minimize Effect of Service Interruptions

TO SUPPLY the rapidly increasing demands for electric power in that section of New Jersey which it serves Public Service Electric & Gas Company will soon have in operation the initial parts of two large transformer stations, one situated at Athenia, about 10 miles from Newark, and the other near Trenton. These stations were designed and are being built by the Public Service Production Company, engineers and constructors, associated with the Public Service Corporation of New Jersey. This article gives only an outline of the design, together with a few of the more interesting construction items. A more detailed description of the design and of the operating features of these two stations will appear in a future issue of the ELECTRICAL WORLD.

The principle followed in the design was to minimize the effect of service interruptions, at the same time avoiding complexities that might prove bewildering to the operators during an emergency. In the construction particular attention was directed toward assembling in the shop as much equipment as feasible, thus lessening the amount of field work.

The Athenia transformer, or "switching," station will receive its power at 132,000 volts from the Kearny generating station, 11 miles away, and will step this down to 26,400 volts for distribution to various substations. Arrangements are being made at the present time for four 132,000-volt lines. The present capacity of the Athenia station is 90,000 kva., with nine 26.4-kv. feeders and no condenser equipment, whereas the ultimate capacity is to be 180,000 kva. and forty 26.4-kv. feeder positions, with about 80,000 kva. in synchronous condenser equipment. There are expected to be eight 132,000-volt power lines finally in the installation. Provision is made at this station for the installation of future indoor synchronous condensers for power factor correction and voltage regulation.

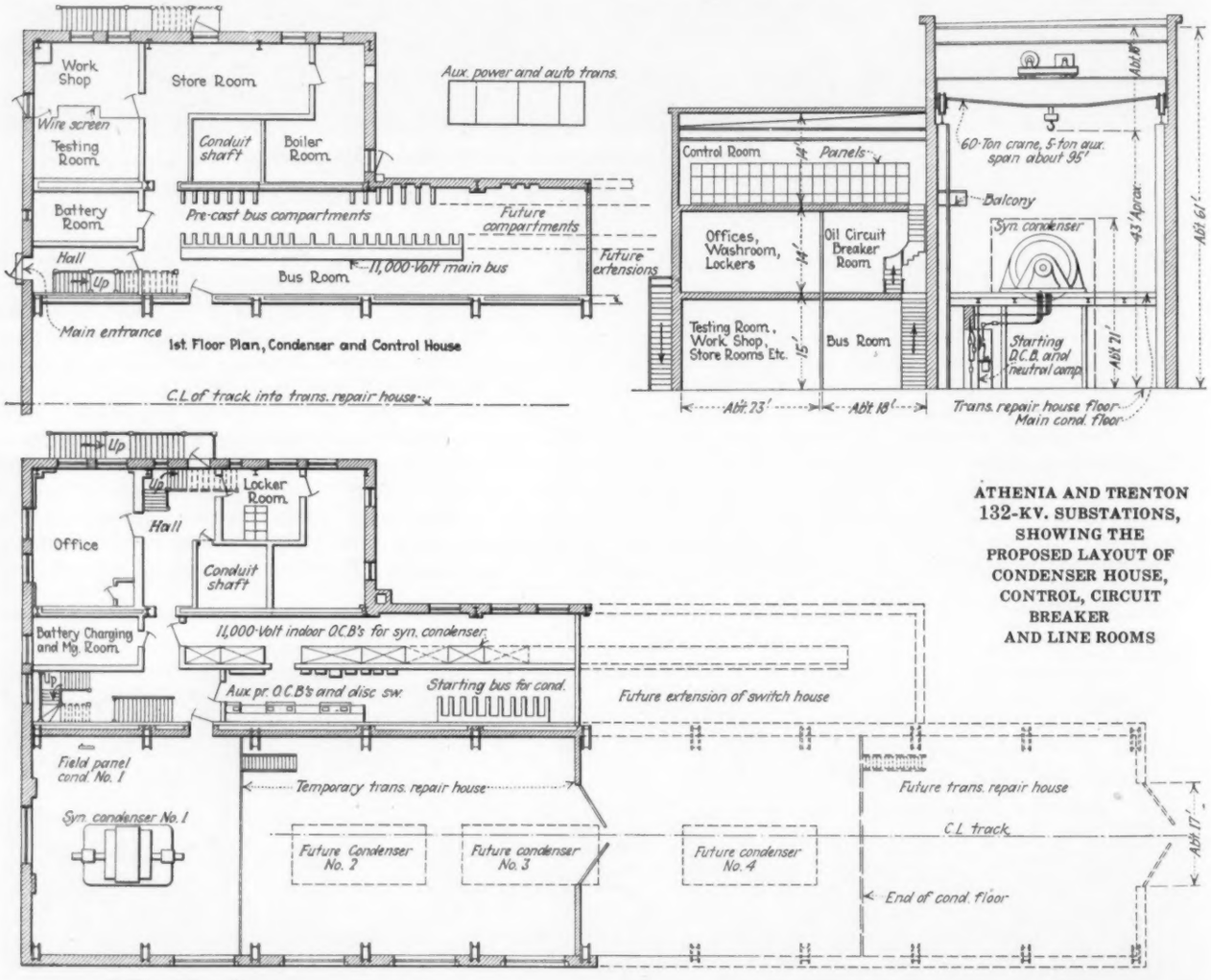


GENERAL ARRANGEMENT, SHOWING SECTIONS OF 132-KV. OUTDOOR SUBSTATION

These condensers are to be operated from the 11,000-volt tertiary winding of the main transformers, which in the initial installation are arranged in two banks, each consisting of three single-phase, 15,000-kva. units. There is one spare unit.

As the Public Service Electric Company's 132-kv.

power lines do not extend to Trenton, an arrangement has been made with the Philadelphia Electric Company for the temporary supply of 66-kv. power over two lines to the Trenton transformers, the secondary voltage of which is 26,400 volts. At the same time these transformers and all other high-tension equipment have been built for future 132-kv. operation. The Trenton switching station is similar to that at Athenia except that each of the two banks of transformers is made up of three single-phase units of 10,000 kva. each, thus giving a present capacity of 60,000 kva. with



ATHENIA AND TRENTON 132-KV. SUBSTATIONS, SHOWING THE PROPOSED LAYOUT OF CONDENSER HOUSE, CONTROL, CIRCUIT BREAKER AND LINE ROOMS

six 26.4-kv. feeders. The ultimate capacity is expected to be 120,000 kva. with thirty-two 26.4-kv. feeder positions.

INSTALLATION OF SYNCHRONOUS CONDENSER

At Trenton a 15,000-kva. synchronous condenser is being installed for power factor correction. It will operate from the 11,000-volt tertiary winding of the main transformers and will have a stationary dry air filter for cleaning the cooling air. The machine will also be equipped with CO_2 fire-extinguishing apparatus. The ultimate capacity of the condenser equipment at this station will probably be 60,000 kva.

A large building is provided at each station to house a control room, tertiary and auxiliary power (440-volt) switch and bus rooms, condenser room, transformer assembly and repair room, battery room, motor-generator room, kenotron test room and workshops and office. The present installation at the two stations requires the laying of approximately 50 miles of conduit of all sizes.

The switchboard panels in each control room are arranged to form three sides of a quadrangle, with the 132-kv. panels facing the 26.4-kv. panels and the condenser and auxiliary power panels taking up the third side. The open fourth side affords the operators a good view of the substations outside.

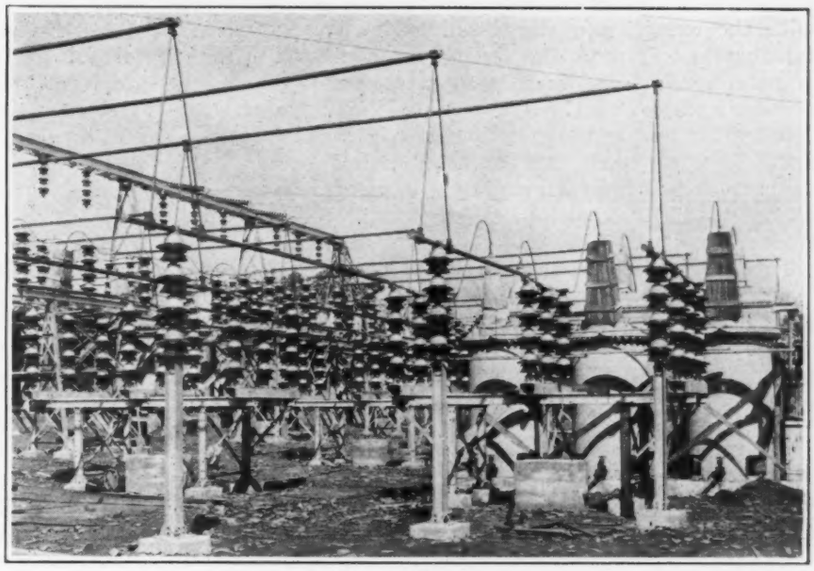
The outdoor busing is done almost entirely by means of copper tubing. The main buses on both the high-tension and the low-tension side are 3 in. in outside diameter, the joints being made by means of another piece of tubing as an inside shrunk connector. The high-tension buses are supported on posts at a distance of about 12 ft. above the ground level. This makes a very simple structural arrangement, the total weight of steel for the high-tension side at Athenia being 50 tons. All structural material for the substations is hot-dip galvanized steel, with the main members almost entirely of single-rolled sections. Members were assembled as far as possible in the shop, shipping clearances being the limiting consideration.

With the exception of the tanks, each phase of the 132-kv. breakers was trucked, completely assembled, on wooden frames directly from the factory to the site. It was then readily inserted in its tank by means

of a motor truck crane. The 26.4-kv. breakers were shipped by truck, completely assembled, directly to their location in the substation.

EQUIPMENT RECEIVED COMPLETELY ASSEMBLED

Each phase of the 26.4-kv. disconnecting switches was shipped and erected completely assembled. The 132-kv. switches, all motor operated and of the double-break horizontal type with four unit insulator stacks, were in general shipped complete per phase, but with only one insulator per stack. Three unit insulator posts came assembled and were inserted in the field to complete these switches. The duplex 132-kv. disconnecting switches, with five insulator stacks per phase, required somewhat different shipping and erection arrangements.



DETAILS OF 132-KV. BUS

Major Equipment of Athenia Switching Station

Seven transformers: 15,000 kva. at 132 kv.; 18,500 kva. at 26.4 kv.; 6,667 kva. at 11 kv.

Six O.C.B.'s, 800 amp., 132 kv.

Two O.C.B.'s, 400 amp., 132 kv.

Six duplex T.P.S.T. motor-operated, horizontal double-break disconnecting switches, 800 amp., 154 kv., four with hand-operated grounding switches.

Seven T.P.S.T. motor-operated, horizontal double-break disconnecting switches, 800 amp., 154 kv.

One S.P.S.T. duplex hand-operated, 800-amp. disconnecting 132-kv. transformer neutrals.

Six 1,600-amp., 37-kv. transformer O.C.B.'s.

Ten 400-amp., 37-kv. feeder O.C.B.'s.

Six 1,600-amp., 37-kv. choke coils.

Twelve 1,214-amp., 1,067-volt, single-phase, outdoor, self-cooled reactors, 7 per cent reactive drop in 55,500-kva., three-phase, 26,400-volt circuit.

Six 1,600-amp. T.P.S.T. horizontal double-break, gang-operated by hand, 37-kv. disconnecting switches.

Fourteen 1,600-amp. T.P.S.T. vertical-mounted, vertical-break, gang-operated by hand, 37-kv. disconnecting switches.

Twenty-one 400-amp. T.P.S.T. vertical-mounted, vertical-break, gang-operated by hand, 37-kv. disconnecting switches.

Ten 400-amp. T.P.S.T. horizontal double-break, motor-operated 37-kv. disconnecting switches.

Forty-six 300-amp. vertical-mounted, vertical-break, S.P.S.T. stick-operated disconnecting switches.

Eighteen 300-amp. S.P.D.T. duplex underhung, stick-operated, 37-kv. disconnecting switches.

Nine 26.4-kv. auto valve lightning arresters.

Five three-phase banks, 26,400-volt potential transformers.

Two three-phase banks, 45-kv. Niagara C.T.'s.

Two three-phase, 250-kva., 26.4-kv., 440-volt auxiliary power transformers.

For Trenton Only

(In addition to similar equipment as for Athenia)

One 15,000-kva., 11-kv. synchronous condenser with starting compensator.

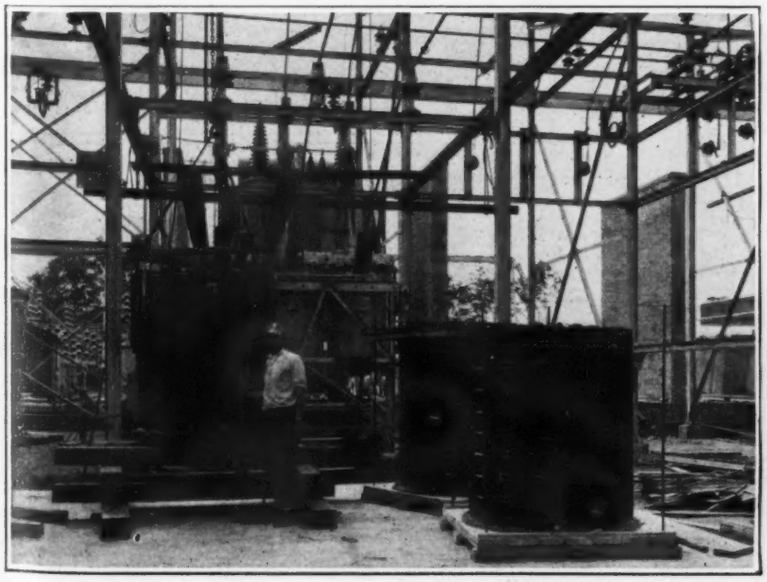
One 800-amp., 15-kv. indoor O.C.B.

Four 1,200-amp., 15-kv. indoor O.C.B.'s.

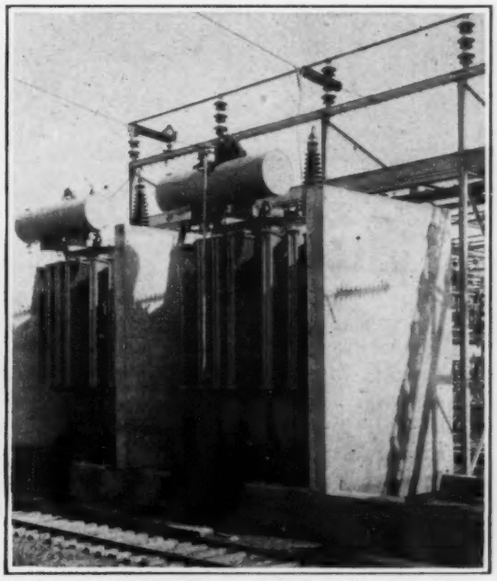
One 500-amp., 15-kv. indoor O.C.B.'s.

Twenty-one 1,000-amp., 25,000-volt, S.P.S.T. stick-operated disconnecting switches.

Thirteen 400-amp., 25,000-volt S.P.S.T. stick-operated disconnecting switches.

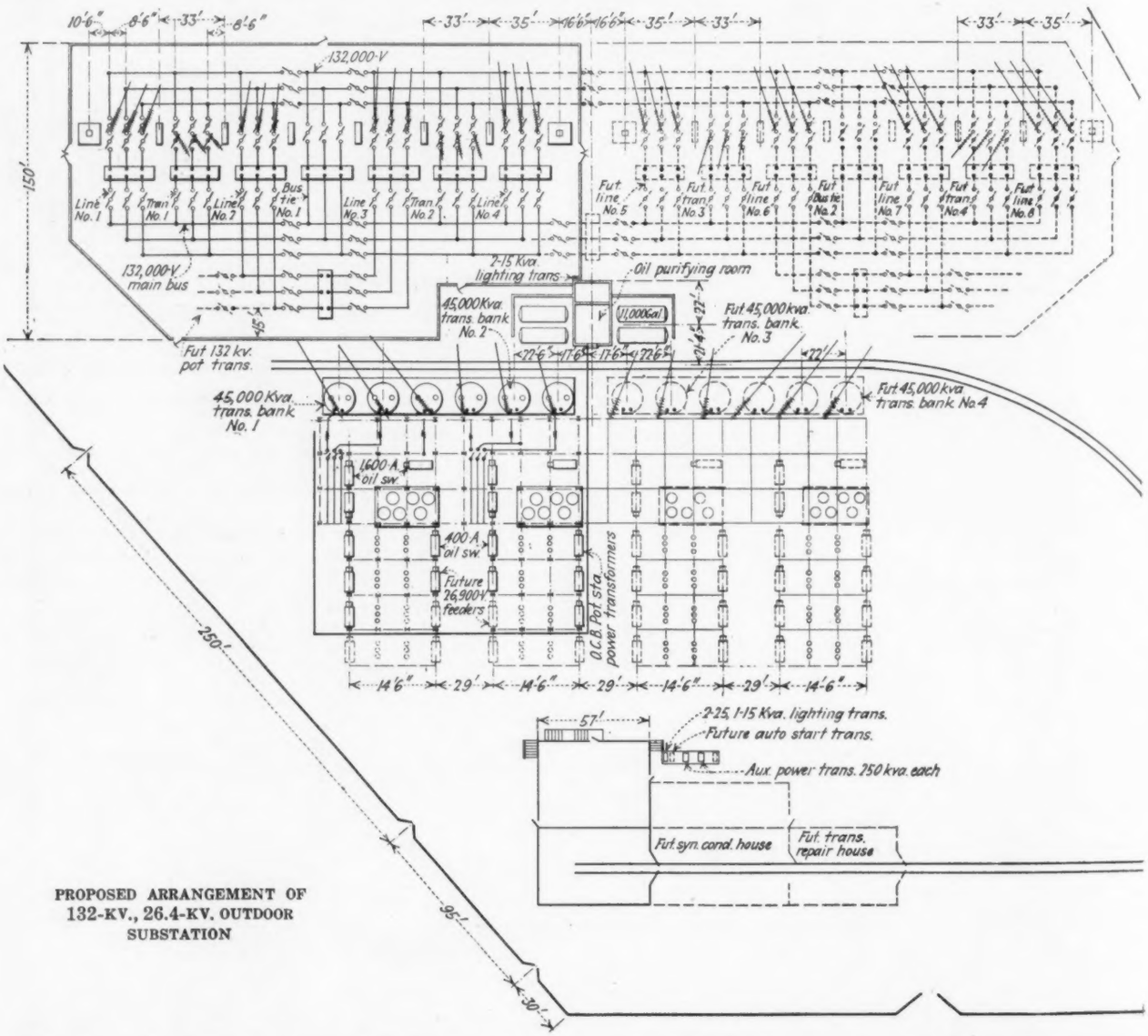


26,000-VOLT, 820-AMP., 7 PER CENT REACTORS—TWO SECTIONS AS SHOWN ARE SUPERIMPOSED FOR EACH PHASE



15,000-KVA., 132-KV., 26.4-KV., 11-KV. O I.S.C. MAIN TRANSFORMERS

Each transformer came completely assembled in oil, with the exception of the bushings, radiators and a tank extension piece. The assembly was effected in the transformer house (which is an extension of the condenser room), and the transfer to the transformer foundations was made by means of a gasoline locomotive. This was considered the best possible method, on account of the grade and curvature of the tracks necessitated by the ground limitations, in spite of the bad load factor such a locomotive will necessarily have during regular station operation. The transformer track at Athenia has a minimum radius of 150 ft. on a 3 per cent grade; this required rather careful design



PROPOSED ARRANGEMENT OF 132-KV., 26.4-KV. OUTDOOR SUBSTATION

of the transformer transfer cars and of the rails, in order safely to take care of the transformers weighing 83 tons and standing more than 30 ft. from the top of the rail to the top of the high-tension bushings. Each transformer transfer car is equipped with a hand winch, so that a transformer can be readily pulled on or off its foundation by two men.

At each switching station the oil for transformers, as well as for high-tension and for low-tension breakers, will be handled from an oil house located near the center of the 132-kv. side. Transformers and 132-kv. breakers are permanently piped to the oil system, whereas the low-tension breakers will be connected by means of flexible tubing, one connection point serving several breakers. For the cleaning of the transformer oil both centrifugal apparatus and filter presses are to be used.

One of the features of the installation is the use of outdoor 26.4-kv. reactors. These are of the single-phase, self-cooled type, with a 1,214-amp. 7 per cent rating at Athenia and an 820-amp. 7 per cent rating at Trenton. There are two sets of these reactors per 26.4-kv. feeder group, one set being used in series with the 26.4-kv. emergency group feeder breaker and the other set at the connection of each 26.4-feeder group to the tie bus.

The neutrals of the transformer secondaries at Athenia will for the present be either open or solidly grounded, but those at Trenton will be grounded through an outdoor resistor.

The foundations at Athenia are on shale 3 or 4 ft. from the surface, and at Trenton on clay and gravel.

The construction of these stations started in the early spring. They are expected to be ready for operation by the middle of October.

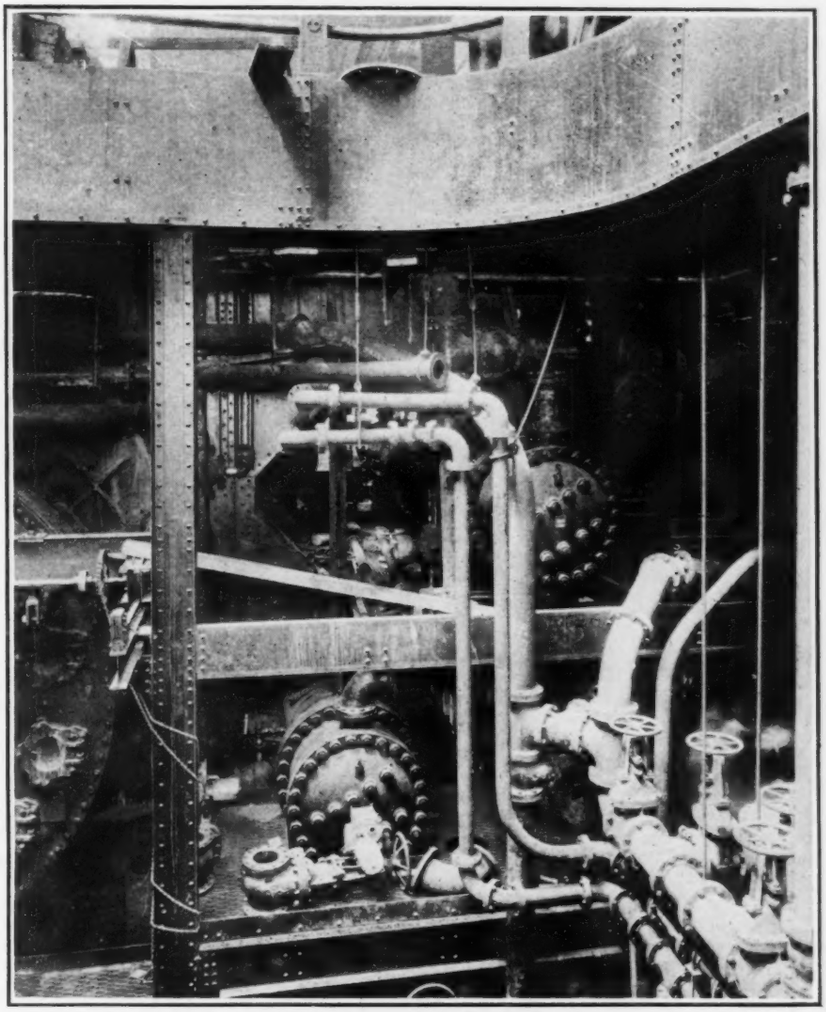
Recent Developments

as Affecting Design and Construction of Power Plants

By WALTER PALMER GAVIT
Mechanical Engineer Dwight P. Robinson & Company

Reheating, Regeneration, Preheating and Burning of Pulverized Coal Have, Except for the Last, Not Imposed Large Changes in Practices of Power House Design and Construction

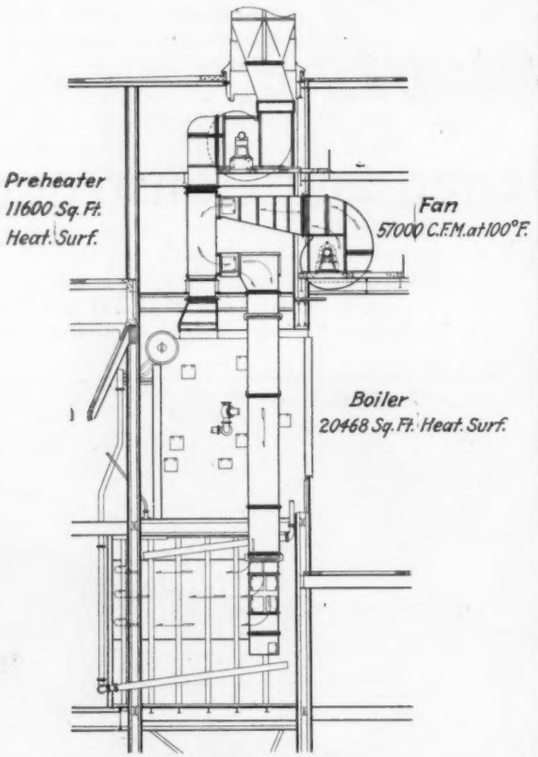
FOUR outstanding developments in the design of the steam end of modern power stations have occurred within the past few years: the regenerative cycle, involving extraction of steam from the turbines for heating feed water; the reheating cycle, involving removal of the steam from the turbine after it is partly expanded, resuperheating it to a high temperature and returning it to the turbine; the use of air preheaters to return some of the heat of the flue gases to the furnaces, and the burning of coal in pulverized form. Although these developments have materially increased the thermal efficiency of power production, for the most part they necessitate but little change in the structure of the station as a whole. The regenerative cycle necessitates practically no modification in the structural design of the power station or of its contained parts. A four-stage bleeder heating system, which represents the most economical construction with steam pressures in the neighborhood of 500 lb. per square inch, can usually be introduced into an existing design with only minor changes in turbine foundation arrangement. It is desirable that the heaters be placed as close as possible to the turbine. They can usually be placed within the turbine foundation directly beneath the high-pressure end of the machine. Heaters may be placed within a steel foundation a little more readily than in one of concrete on account of the greater space that is available.



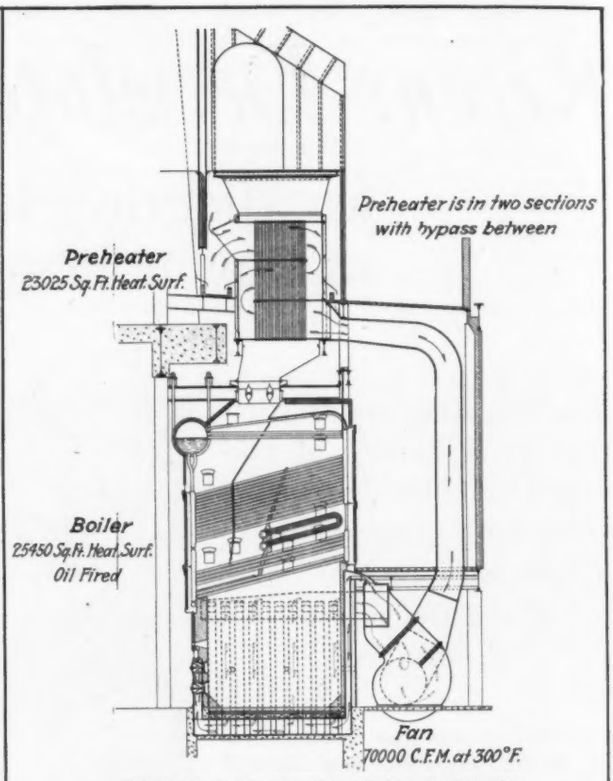
BLEEDER HEATERS REPLACING REGENERATIVE SYSTEM

An arrangement of bleeder heaters in a station that was originally designed for a house turbine type of heat balance is illustrated. This installation required no modification of building arrangement and in fact made some additional space available due to the elimination of a considerable amount of auxiliary steam and exhaust piping. The greatest difficulty met with in constructing this installation was to provide sufficient flexibility in the leads from the turbine to the heaters. These leads are of necessity short and consequently stiff, but proper flexibility was provided by installing a section of copper pipe in each connection. The installation in a station originally designed for a regenerative system is also shown. The heaters may be seen to the left of the condenser.

In building this type of installation particular care



PREHEATER INSTALLATION
OHIO RIVER EDISON CO.
Stevens & Wood Engineers



TUBULAR AIR PREHEATER INSTALLATION
LOS ANGELES GAS & ELECTRIC CORP.
Dwight P. Robinson & Co., Inc. Engineers

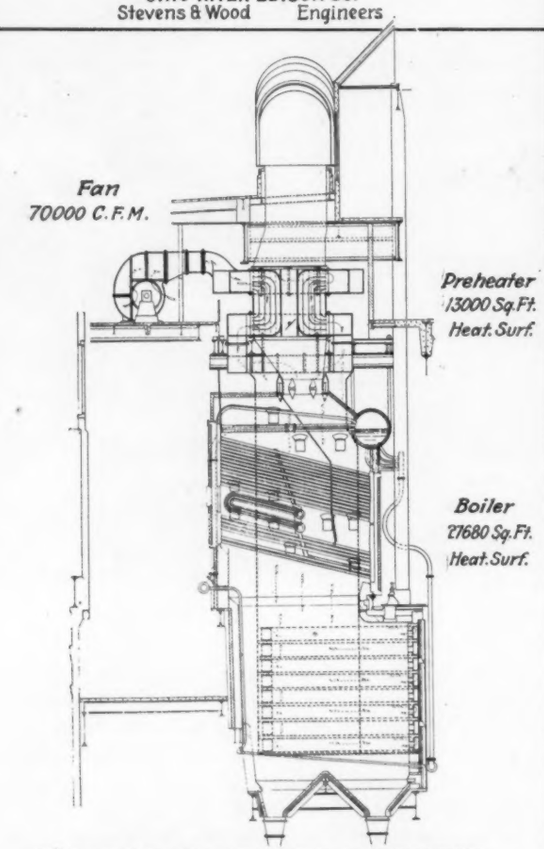


PLATE TYPE AIR PREHEATER INSTALLATION
PULV. FUEL FIRED BOILERS COLFAX STATION
DUQUESNE LIGHT COMPANY
Dwight P. Robinson & Co., Inc. Engineers

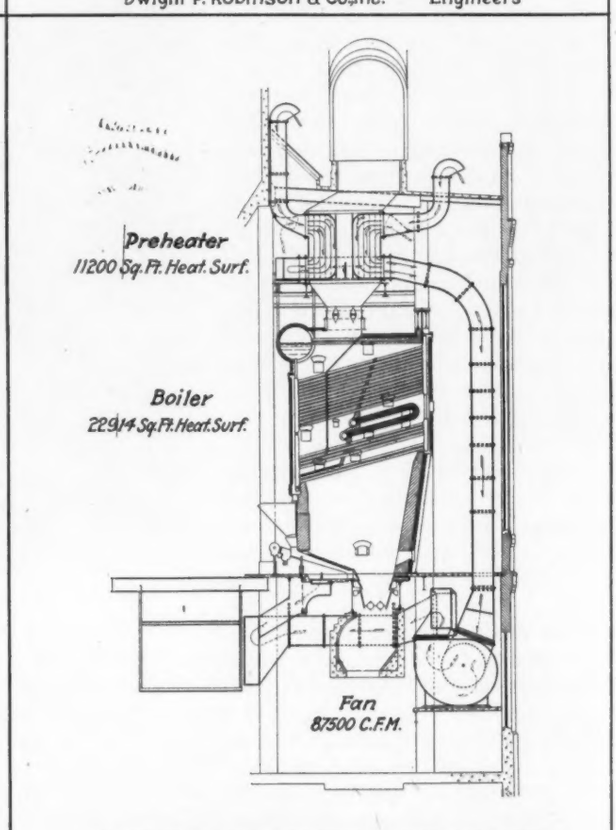
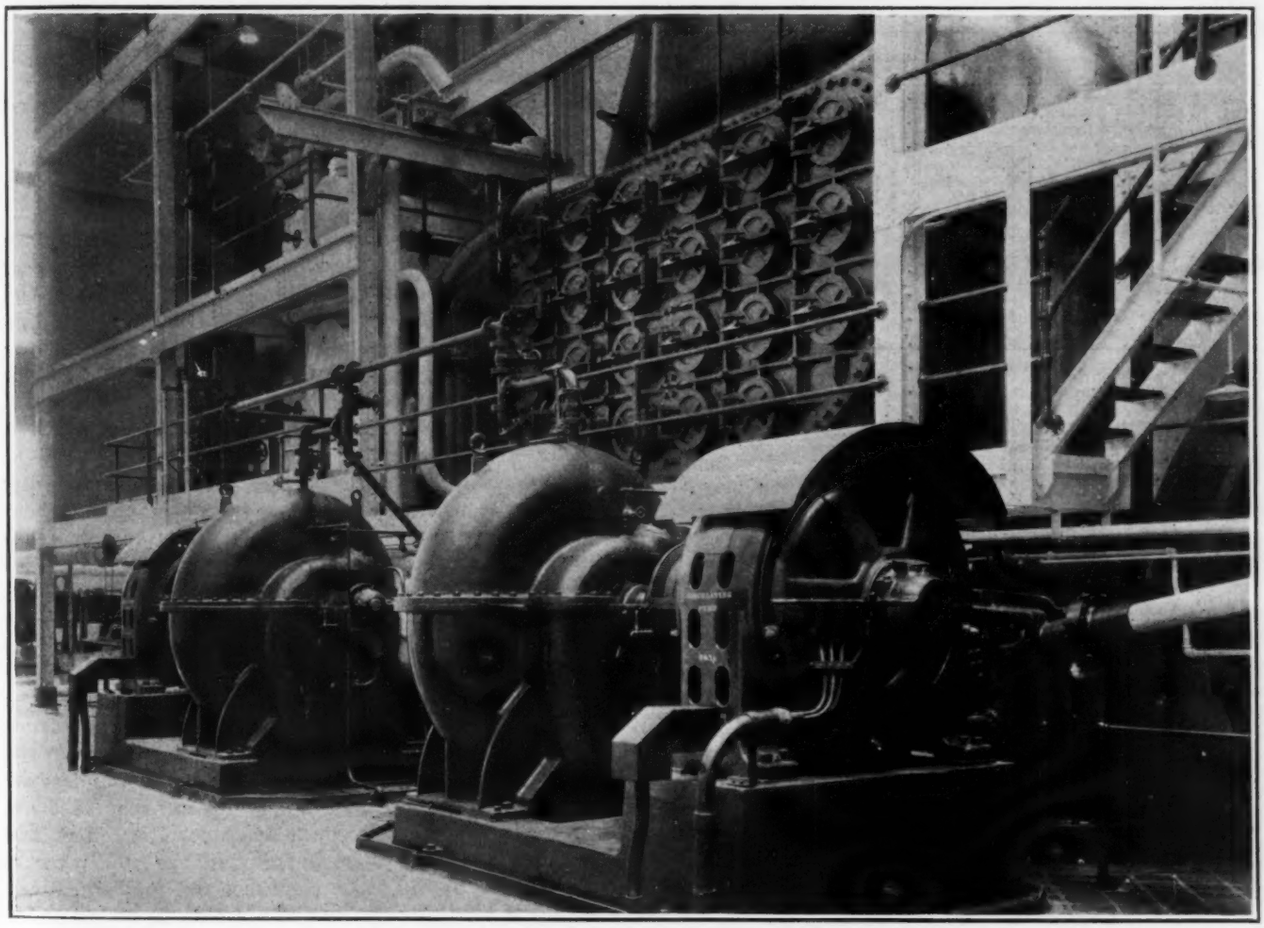


PLATE TYPE AIR PREHEATER INSTALLATION
STOKER FIRED BOILERS COLFAX STATION
DUQUESNE LIGHT COMPANY
Dwight P. Robinson & Co., Inc. Engineers

TYPICAL AIR PREHEATING INSTALLATIONS

must be exercised to guard against vibration transmitted from the turbine foundation to the heaters. Although the turbine may run with little or no apparent vibration, it will often be found that certain members of the foundation possess inherent vibration characteristics, with a natural period close to that of the turbine, so that vibration of marked intensity appears in these members. If a heater is supported by such members, trouble will be encountered through vibration of the tubes in the tube support plates. It is impracticable to predetermine the existence of such conditions and so guard against them in the design of the turbine foundation. Difficulty of this sort can be avoided by erecting a separate supporting structure within the turbine foundation to carry the heaters and heater piping. Columns for this structure can be placed inside the H sections of the main foundation columns so that the heater support structure need occupy little additional space.



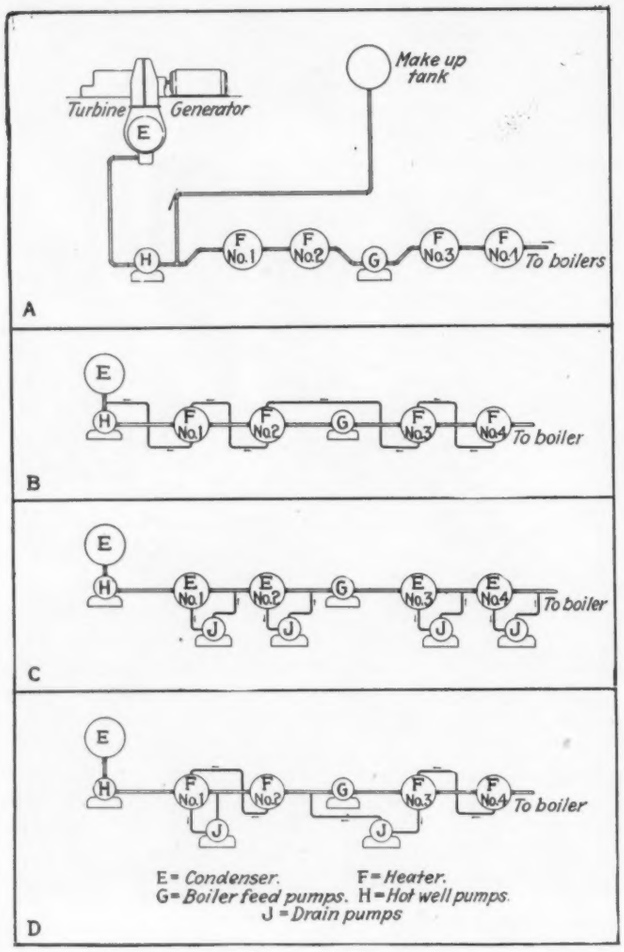
BLEEDER HEATERS INSTALLED IN EXISTING STATION

A number of different arrangements of regenerative heat cycle have been built within the last few years, and considerable difference of opinion exists as to the relative economy of different types. There is little question, however, that simplicity of design and of operation should be the controlling factor. The system of handling the drains from the heaters and the placing of hot well and boiler feed pumps in the cycle may easily cause undesirable complication and adversely affect the economy. The simplest pumping arrangement is that shown at *A* in the schematic drawings. In this case the hot well pump is designed to deliver water at a pressure somewhat in excess of that corresponding to the maximum temperature of the water leaving the second heater. The boiler feed pump is introduced between the second and third heaters and the third and fourth heaters are subjected to boiler feed pressure. This pressure condition does not cause any difficulty either in the design or in the operation of the heaters. The addition of any more pumps into the main flow of the condensate results in increased complications with no compensating increase in either reliability or economy.

The make-up or surge tank shown is placed at an elevation such that the desired pressure will be maintained at the boiler feed pump suction, and water may flow into or out of the tank as the demand of the feed pump requires. This system requires no float valves and is entirely automatic in its operation. Systems in which make-up is introduced into the condenser hot well require several valves for their operation and are therefore dependent upon the integrity of these valves.

The arrangement of the heater drains is of considerable importance. The simplest arrangement is to carry the drains down from heater to heater, finally discharging those from the low-pressure heater into the hot well as shown at *B*. This, however, results in an appreciable loss in cycle efficiency due to carrying heat from the higher to the lower heaters and should be avoided as far as practicable limitations will permit. Although the ideal arrangement would be to pump the drains from each heater into the condensate flow leaving that heater as shown at *C*, such practice requires a number

of small pumps, which would have to work under decidedly disadvantageous conditions. It is practicable, however, to pass the drains from the high-pressure to the next lower heater and to pump the accumulated drains from this heater into the condensate flow at the boiler feed pump suction. Then the drains from the second heater may be passed to the low-pressure heater and the accumulated drains therefrom pumped into the discharge from that heater. This system is shown at *D*. Passing these drains to the hot well causes considerable loss of possible heating in the low-pressure heater. Since this heater is the most efficient of all, curtailment of its work should be avoided as far as possible. The system shown at *C* requires two pumps,



SCHEMATIC ARRANGEMENTS FOR REGENERATIVE HEAT CYCLE

which may conveniently be driven by a common motor. The low-pressure pump requires some power at all loads, but the high-pressure pump requires no power except when the load on the turbine is light, as the pressure in No. 3 heater is greater than the required pressure at the boiler feed pump suction except at light load. The power requirement for these pumps is of the order of 1 or 2 hp. for a 35,000-kw. installation.

The reheating cycle involves more additional construction than the regenerative cycle. The steam removed at relatively low pressure for reheating requires large piping back into the reheater boiler. Bypass connections must be provided so that in case of trouble with the reheater the unit can be kept in operation.

There is some doubt whether this cycle can be justified by the economic gains possible through its use. In a station using steam at 565 lb. and 700 deg. the relative heat rates for three types of cycle are as follows:

1. Straight four-stage regenerative with air heaters, 13,360.

2. Four-stage regenerative with reheat air heaters, 12,910.

3. Three-stage regenerative with reheat air heaters and economizers, 13,030.

With coal at $5 per ton and 11,000 B.t.u. per pound and a 50 per cent station load factor, the excess capital expenditures per kilowatt warranted on a basis of 15 per cent fixed charges for type 2 over type 1 would be $7.80, and for type 3 over type 1 would be $2.20.

If these expenditures were required to return a profit of 10 per cent on the additional capital expended, the excess cost per kilowatt of station capacity warranted would be $4.68 and $1.32 respectively. From this it can be seen that the reheating cycle is of doubtful economy as long as fuel costs remain at approximately their present level.

The reheat cycle reduces the amount of boiler surface necessary, but, due to the apparent necessity of making the reheat boiler a separate element, increases the number of boiler units. The relative boiler surface requirements, not including reheater surface, for the three cases cited above are as follows: (1) 100 per cent, (2) 87.8 per cent, (3) 90.6 per cent. In cases 2 and 3 a separate boiler element must be installed to contain the reheating element.

Air preheaters can often be installed in existing boiler plants with practically no structural changes and can be incorporated into a new design without increase of building cost.

The development of air preheaters as a heat-reclaiming device for central stations began in this country with the installation of two experimental heaters in the Colfax station in 1922. These heaters, of the plate type, fully justified their cost, though their design was not so good as that now obtainable. When the installation was first proposed, fears were expressed by the stoker manufacturers that the heated air would cause trouble with the stokers. Their feeling was that the heated air would not have sufficient cooling effect and consequently would cause burning of the stoker parts. This was not found to be the case, and the indications are that if anything the heated air reduces stoker maintenance. When preheated air is used with pulverized fuel, the resulting increase in furnace temperature requires some special arrangements to protect the furnace walls. The several types of water-cooled walls, though to some extent still in the development stage, provide a satisfactory means for handling the higher temperatures.

If the preheaters reduce the stack gas temperature below 350 deg. F., induced draft fans will be necessary. If the gas temperature is above 350 deg. F., a natural draft may usually be used to advantage. In any case fans will be required to force the air through the preheaters and deliver it to the furnace slightly above atmospheric pressure. The desirability of a balanced draft condition in the furnace is quite generally recognized, and such a condition can be realized only through the use of fans to overcome the resistance of preheater and ducts. Such fans may be placed either on the inlet or on the discharge side of the preheater. If they are placed on the inlet side, the entire duct

system and preheater are subjected to a pressure above the atmosphere, but the fan handles cold air. If the fan is placed on the discharge side of the preheater, the heater and duct system up to the fan contains air at a pressure slightly below atmosphere and beyond the fan up to the furnace openings slightly above atmosphere. The fan in this latter case must of course be larger on account of having to handle heated air and special arrangements must be provided for cooling the bearings. Although in some cases it is practicable to place the bearings outside the fan housings, this cannot always be done conveniently. This arrangement with the fan on the discharge side of the heater introduces some difficulty in providing for expansion in the duct system, particularly where connection is made to the fan housing. Considering all these conditions, it is probably better to place the fans on the inlet side of the preheaters. If the entire duct system is welded, there will be no leakage. Expansion can be more readily provided for, as the difficulty of making flexible connection to the fan is eliminated. The four drawings of actual installations show different ways of arranging the fan and duct work. In two of these installations the fans are on the inlet side, and in two they are on the outlet side of the preheater.

In the installations shown the heated air is passed through the hollow side walls of the furnace to act as a cooling medium. With pulverized fuel or oil firing where high ratings are desired this method of cooling the walls is unsatisfactory and the expense incident to hollow wall construction might better be devoted to a system of water cooling.

Phases of Economical Hydro-Electric Plant Construction

By JOHN F. VAUGHAN
Vaughan Engineers, Boston, Mass.

Importance of Seeking to Control Fixed Charges—Rewards of Detailed Planning—Individual Responsibility More Important than Contract Forms.

THE success of the water-power project, like any other system for converting raw materials into marketable product, depends upon its ability to deliver the product at a profit. Under given conditions of locality, relation to natural competitors and relation to market available, the principal factors affecting this profit are fixed charge and operating expense. The least flexible of these factors and the one most necessary to control at the outset is fixed charges, the cost of carrying the initial investment.

It has been customary in the past to gage the quality of a water-power project as an investment by the first cost in dollars per horsepower or kilowatt of capacity or by first cost in cents per kilowatt-hour of output. In the application of these rules of thumb, the quality of power is too often overlooked; $150 per kilowatt might be the limit for a "run-of-stream" plant built for capacity rather than output and for handling peaks rather than sustained loads, whereas $300 per kilowatt might pay well for a steady, reliable source capable of sustained output at a high load factor. A capital cost of four to five cents per kilowatt-hour of output, a figure frequently used, may be unjustified in the former case and entirely unfair in the latter. A kilowatt of plant capacity installed for handling peak loads of short duration or for relay or stand-by service may average not more than 1,000 hours' operation a year, whereas, on the other hand, by carrying the base of the load with peaks otherwise provided for it may run practically continuously, as in the case of the Niagara plants whose water is limited by international treaty. As a prominent operator recently explained, if quoted correctly: "There are three kinds of water power — 'run-of-stream,' which you have when it is there, and when it isn't, you haven't; 'time power,' ordinarily available throughout the year; and 'super-prime' power, retained in storage for use when most needed. This last is the most valuable kind of power there is; when you want it, you just turn on the spigot and it's there."

WATER-POWER VALUES

As to "profit" above mentioned, it is too frequently thought of only as the margin between the cost at which the power can be produced and its selling price. Other less tangible though very real values in addition often exist—for instance, through its relation to other sources of power or to other markets than its own immediate consumer, as a relay or reserve, as an equalizer between river basins of different characteristics, as a storage of energy or as an electric regulator. Through its ability cheaply to provide capacity to carry short peaks or storage to equalize seasonal variations at the market end of a long transmission line and, by so doing, better the load factor on the line and decrease the unit cost of energy delivered, the water power may take on a special value. In a given development frequently an additional kilowatt of machine capacity may be produced at low cost or additional use of storage become available to reduce investment or increase its return.

As compared with steam, the larger capital investment and fixed charge and the relatively smaller operating expense of a water-power project requires in the latter greater effort in the reduction and control of the larger development cost. The opportunity for reduction of cost of power in the steam plant lies mainly in the improvement of economy, whereas in water power the burden of fixed charges becomes dominant. In the larger investment in lands and water rights, the creation of ponds and reservoirs and the permanence of its dams, canals, roads and other long-lived elements, the opportunity for the water power in the control of its future fixed charges may occur at the outset only and thereafter be gone forever.

THE ENGINEER'S MATERIAL

The factors through which capital cost may be most readily controlled are: Investigation and preliminary planning, design, form of general construction agreement and prosecution of construction.

The value of thorough study of market, operating conditions and relation to other power supplies and systems needs no argument, nor does the effect of the selection of location and layout of works and costs need demonstration, and it is hardly necessary to stress the importance of thoroughness in the study of site, material available and construction conditions or types of structures best adapted to the conditions existing. With a thorough knowledge of these elements, construction estimates may be made as a rule with assurance and the cost closely predicted.

Overdevelopment may become a permanent burden; so also may restriction of capacity, and unless provision can be made for future expansion at reasonable cost, it may react in the same manner. Many an otherwise sound project has been hurt or permanently crippled by lack of adequate study of conditions, present and future, and scrutiny of initial cost.

In the preparation of estimates of cost, the engineer almost inevitably finds himself faced with the natural optimism of the promoter or owner on the one hand and his own caution or pessimism, engendered by past experience, on the other. He may at times grant the logic of the argument that conditions seem favorable and chances of accident or error of judgment slight. He may be under stress or temptation to accept this view or to attempt to place the responsibility on the optimist. He will be negligent and fail in his duties to those whose money he is to spend, however, if he allows his better judgment to be swayed by such considerations or fails to allow in items less sure or more likely to be wrong a sufficient hard luck factor or contingent margin of cost.

REWARDS OF DETAILED STUDY

If a project be well planned or conditions sufficiently known or fixed, the design may be carried along with construction, time saved and carrying charges reduced. The more completely the studies of conditions, materials and details of designs and specifications are worked out, however, the closer can cost and time necessary for completion be predicted, lump-sum bids for construction, if desired, be obtained and savings realized. In the writer's experience, these savings may be considerable. In a recent case the general contractors actually reduced their bid 10 per cent on account of the completeness of plans, specifications and information available.

At times it may be expedient or even necessary to build on the sketchiest of plans, and with some forms of construction or structures this can be and is done with good results; but in hydro work a dollar well spent in preliminaries and in working out of designs is returned many times over in the ultimate cost of construction.

CONTRACT FORMS OF SUBORDINATE IMPORTANCE

Whether construction is done on the "lump-sum" or "cost plus" basis, the management of the work may make or ruin the job. Each method has its place, and both depend on the skill and experience of the contractor and his integrity. Whoever takes the risk must be compensated, and in the long run we get just about what we pay for. The contractor does not want to gamble any more than do those responsible for the investment. It is a case for confidence on the one hand and a square deal on the other, or there is inevitable loss and dissatisfaction. Whether the policy be one of dependence upon the contractor or manufacturer, on the theory that they are more interested in their reputation and future business than in immediate profits, or on supervision and inspection, some one brain in immediate contact with the work must be held responsible for results. Whether this be the contractor, the contracting engineers, the supervising engineer or the owner's man, the general feasibility of the project and especially the schedule set for the progress of the work must be "sold" to the man immediately responsible for the carrying out of that schedule. It has been the consistent experience of the writer that only where this was done has it been possible to get good progress and a satisfactory job.

CONSOLIDATION OF WORK UNDER ONE CONTRACT

Under some conditions, such as a simple, well-concentrated layout of few parts, the consolidation of the work under one contract, even including the engineering, may be the most economical way to build; but often, especially in the more widely spread construction, it may be cheaper to distribute the several items of the work among different contractors—for instance, the dam to one, the pipe line or canal to another and the power house to a third. Although there are strong objections to this in the inevitable division of responsibility and the difficulty of sufficient co-ordination for speed, a local contractor familiar with local help and local conditions may be able to undercut the prices on which an outsider could live. Of course the general contractor can and should employ local aid wherever he can save by so doing, but carried to its logical conclusion, this requires co-ordination and concentrated control by the agent of the owner, whoever such agent may be, and eventually success depends upon the effective control by one responsible head on the job, whether he be the representative of the contractor, contracting engineers, the supervising engineers or the owner. The good contractor wants good results, but his interest is in his own profits as well as in his reputation.

The supervising engineer is concerned with the best results at the least cost to the owner, and if he maintains his proper position, both economic and ethical, he will, as the agent of the owner, see that he gets what he pays for and will at the same time insure fair treatment to the contractor. By this attitude alone can harmony, progress and economy of construction be assured.

FIG. 1—SET-UP OF PART OF CONDUIT FOR TESTS

The expansion chamber is installed on one of the ducts containing a short-circuited cable. The temporary overhead cables in the foreground are used to supply power to both ends of the short-circuited cable

Effect of Cable Short Circuits on Conduit

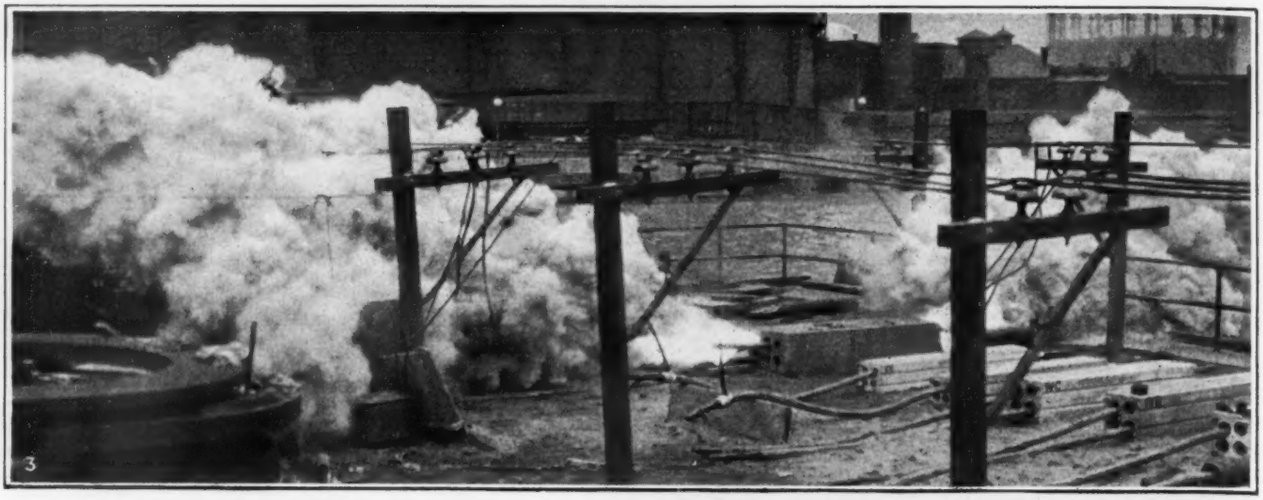
Tests Show Resistance of Conduit Materials to Electric Arcs—Short Cables at 12,000 Volts Operated on Three Types of Ducts—General Results of Tests Given

By W. G. KELLEY and T. C. LECLAIR

Assistant Engineer of Distribution and Assistant Engineer Inside Plant Division, respectively, Commonwealth Edison Company, Chicago

IN AN underground transmission system at times of normal operation, when all parts of the system are functioning as they should, failure of a transmission cable causes an arc that may burn for one-half to two seconds and then be extinguished by the opening of the oil switch at the supply. Under these conditions, experience has shown, there are a number of types of conduit that will prevent the communication of this arc to any of the adjacent cables. However, should the power supply to this arc not be interrupted for any reason and the arc continue for a longer period of time, there is a possibility that the heat and pressure generated will communicate to an adjacent cable and cause further failure. Most underground systems are equipped to withstand the loss of one transmission line without an interruption of service, but should this failure involve other lines, it may mean an interruption of service. For this reason a series of tests was made to determine what types of conduit would be best able to withstand a short circuit lasting more than the usual two seconds without danger of communication to other cables in the same line.

Tests have already been made by the Bureau of Standards and the National Board of Fire Underwriters on the resistance of various materials to ordinary fire temperatures. No satisfactory reference, however, could be found on the resistance of conduit materials to the temperature of the electric arc. For this reason it was decided to make tests under the actual conditions that would obtain with a short circuit on a cable in conduit at line voltage. In this series of tests three general types of conduit were tested—namely, fiber conduit, surrounded by concrete, stone pipe conduit with and without a protection of concrete and monolithic concrete duct structure having no core in its construction. No tests were made on tile duct, because previous experience has shown that this material tends to fuse and sag under continued application of high temperatures. When making these tests, short sections of conduit were made on the surface of the



Flame and Smoke Produced at Instant of Short Circuit

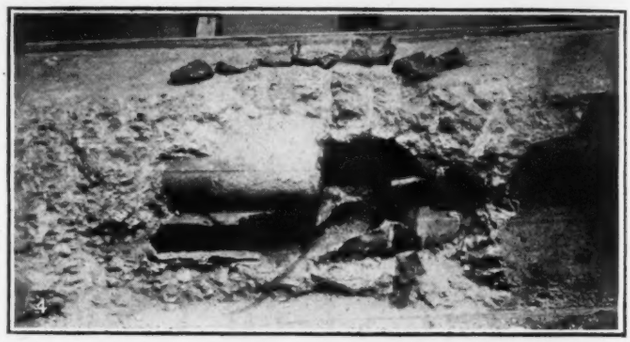
Fig. 3—Instantaneous photograph of short circuit in cable Taken after about 2½ seconds.

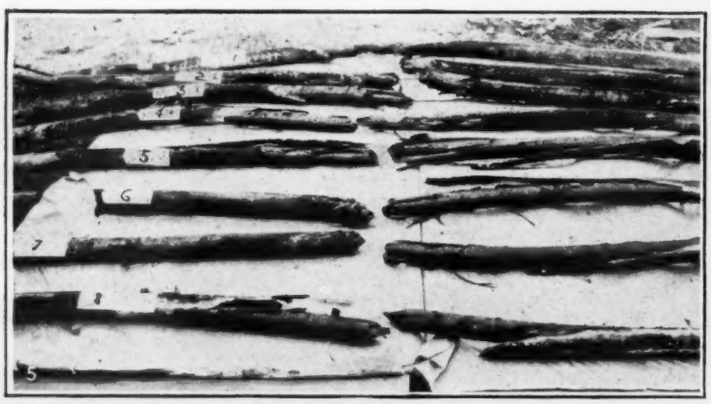
Fig. 4—Effect of arc on conduit. Protecting concrete has been chiseled off after test to show shattered ducts.

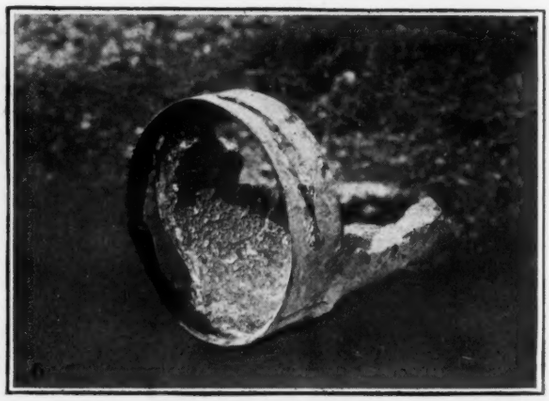
Fig. 5—Remains of cables from tests.

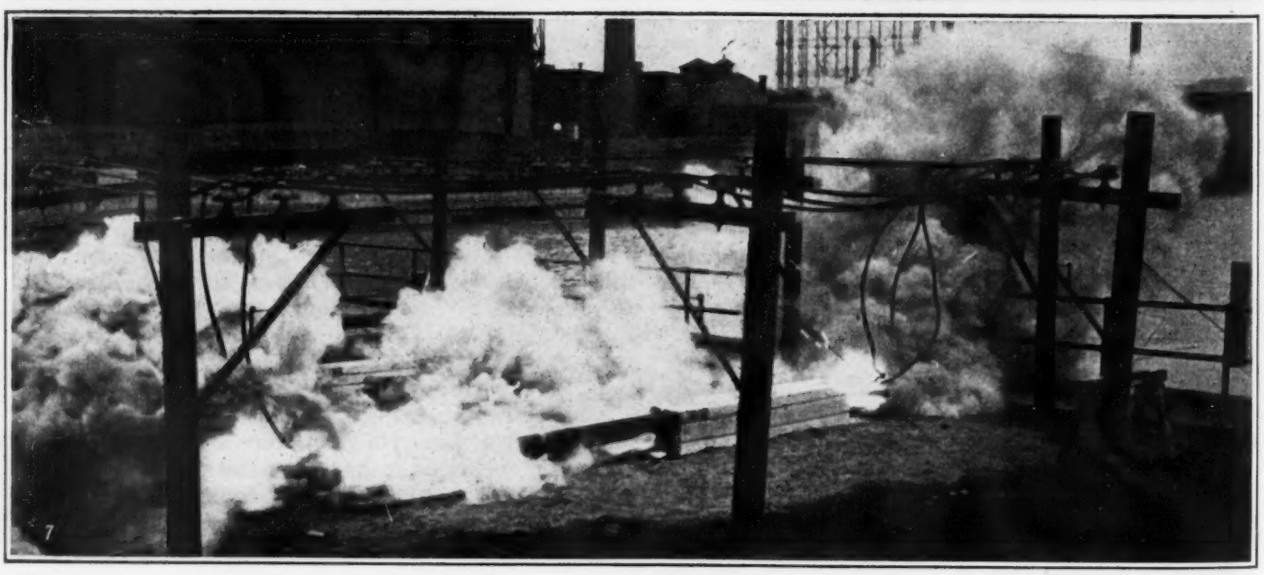
Fig. 6—Close-up of joint in duct containing short circuit. Note the rough inner surface and the hole burned in the binding band.

Fig. 7—Instantaneous photograph of short circuit. Taken after about 2½ seconds. Compare with time exposure of same test, Fig. 8.









ground for convenience in inserting and removing cable and in dissecting after the explosion.

The so-called stone conduit was a precast cement and sand or cement and limestone tubing made in lengths of 3 ft., with a 3½-in. inside diameter and a ⅝-in. wall. When hardened, these ducts are installed in concrete with a sheet-metal ring around each joint to hold the fresh concrete while hardening. For the tests this conduit was made up in a four-duct section 16 ft. long. The fiber conduit comes in 5-ft. lengths with a 3½-in. inside diameter and ¼-in. wall. This conduit was also made up in a four-duct section 16 ft. long.

The monolithic conduit, of which the Murray system is a method of laying, has no permanent core, but is concrete molded in place and the core removed. The Murray ducts tested were 4 in. diameter in a section two high and three wide. It was made by a machine in which concrete is tamped around a movable form in a section about 6 in. long. The form is then moved forward step by step, making a continuous structure with the core removed. The test section was about 7 ft. long. The other monolithic sections were made in a special mold which was 7 ft. long with steel pipe cores and was stood on end for pouring or tamping. This method has no practical value, but was a convenient means of getting different wall thicknesses for test. The Elecrete referred to in the monolithic ducts is a patented high-strength mixture made by the Electrical Concrete Company.

The concrete fill between ducts as they were placed side by side for successive tests varied from zero to 2 in. under the different conditions that were imposed upon the cables.

In all cases the short circuits were made in three-conductor, 500,000-c.m., 12,000-volt cable either single-phase or three-phase. For the single-phase circuits a small nail was driven through the lead sheath into one of the conductors and full 12,000 volts applied between the sheath and conductor. The three-phase short circuits were made by wrapping a very fine wire around the three conductors and replacing the insulation and lead to simulate a normal cable with a weak point in the insulation. For the tests on the 14-ft. sections the ends of the duct containing the short circuit were loosely plugged with waste and the like. For the shorter sections the ducts were plugged with cement, except in the case of the last four tests, in which an

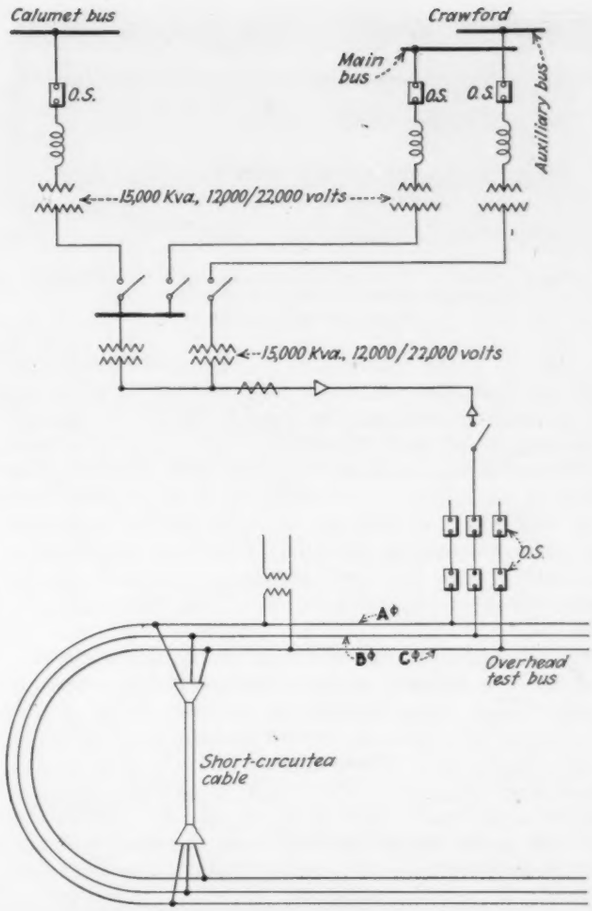


FIG. 2—ONE-LINE DIAGRAM OF POWER SUPPLY FOR CONDUIT TESTS

The 22,000-volt lines shown are regular transmission tie lines from Fisk Street station to Crawford and Calumet stations. The tests were made on Fisk Street property with no connection to the Fisk Street bus.

expansion chamber was put on one end of the duct to allow some escape for the gases as would be the case with a short circuit in a long duct section. This expansion chamber in action is shown in Figs. 6 and 7.

The power supply for making these tests was obtained from Calumet and Crawford generating stations, of the Commonwealth Edison Company, over 22,000-volt transmission lines as shown in the diagram,

FIG. 8—TIME EXPOSURE OF SHORT CIRCUIT IN ONE TEST. EXPOSURE WAS FROM THREE SECONDS BEFORE TEST TO TWO SECONDS AFTER. NOTE THE APPARENT LACK OF THE SMOKE SHOWN SO PROMINENTLY IN FIG. 7

FIG. 9—VIEW OF CONDUIT SPLIT LONGITUDINALLY AND ONE HALF INVERTED ON TOP OF THE OTHER TO SHOW BOTH SIDES

Fig. 2. By these connections a high short-circuit current was obtained without a severe shock to either of the generating stations. In order to obtain the desired time interval of short circuit the ordinary relays were not resorted to. Two oil switches were connected in series in the 12,000-volt circuit, with the controls for both switches operated by a motor-driven contactor. The contacts could be adjusted to get any desired time interval between the closing and opening of switches regardless of what the short-circuit current might develop to.

The amount of energy absorbed in the arc was measured by a somewhat novel method. Potential transformers were connected across the terminals of the short-circuited cable and current transformers were put in the supply lines. These current and potential instruments were then connected to a three-phase graphic wattmeter having a high chart speed. By integrating the area under the curve drawn by the needle of the instrument the amount of energy input to the arc could be fairly accurately measured.

PHOTOGRAPHIC RECORDS OF TESTS

A photograph of the effect on the conduit from test 6, which showed communication to an adjacent duct, is shown in Fig. 4. Due to the lack of support between the ducts, which were laid without any separating barrier of concrete, it may be seen that the combination of heat and pressure caused by the arc shattered the stone duct and permitted the gases to pass into the adjacent duct, burning the cable. The effect on the inner surface of the conduit and on the binding ring from test 8 is shown very clearly in Fig. 6. Note the very rough surface. Figs. 3, 7 and 8 show the amount of flame and smoke produced at the instant of the short circuit. It is rather interesting to note the difference between Figs. 7 and 8, which are photographs of the same test. Fig. 7 is an instantaneous photograph showing the rapidly rising smoke, and Fig. 8 is a time exposure over the entire time of short circuit, in which only the flame shows and the smoke is apparently blanked out. Fig. 5 is a photograph of the remains of the cables from the last eight tests. They are numbered consecutively, No. 1 being from test 10, No. 2 from test 11, and so on. The lead had been burned away for several feet back from the short circuit and most of it blown away in the form of vapor, as very little was found in the duct. Another evidence of the force of the explosion is that the cement plug from one of the ducts was found plastered to a vertical piece of board, 10 ft. from the end of the duct after the test. Fig. 9 is a photograph of longitudinal section of another conduit tested. What appear to be the two center ducts in the photograph are in reality the two halves of the duct that contained the cable that was short circuited.

ARCS UNDER TEST CONDITIONS

An interesting sidelight brought out in these tests was the characteristics of the arc in the cable. The upper wave in the oscillograph record, Fig. 10, shows the arc voltage, and it may be noted that it is fairly constant after the first few cycles. This is apparently due to confining the arc under a high pressure and temperature. The peculiar change in amplitude of the voltage wave may be explained by the fact that the arc resistance is rather high at the instant the short circuit is made, then becomes lower as the burning proceeds and again rises due to the high pressure of gases generated within the duct.

There is one rather important difference between materials used in the conduit which is independent of the method of formation. A duct made of sand and cement, for instance, whether it be a molded duct surrounded by a fill, or a monolithic sand and cement structure, forms a glass surface due to fusion of the silica sand. This glass when melted absorbs particles and vapor of copper and leaves a very tough surface with many sharp projecting edges. The surface would have a tendency to injure the lead sheath of the cable pulled in to replace the one that failed. Limestone under the influence of heat does not tend to fuse, but appears to be driven off as a vapor. This leaves a surface rather soft and porous and allows the copper particles to form a coating over it. This would probably not injure the sheath of the cable pulled in quite so much as would the silica surface. Fiber burns away very quickly under the influence of the arc, but the one duct tested left a very smooth surface of concrete under the fiber and the projecting edge of the fiber was rounded in such a way as not to interfere with pulling the cable.

Briefly summarized, it may be said that so far as protection against arcs is concerned, any type of duct will be satisfactory provided there is at least a 1-in. wall of concrete without cracks between any two adjacent ducts.

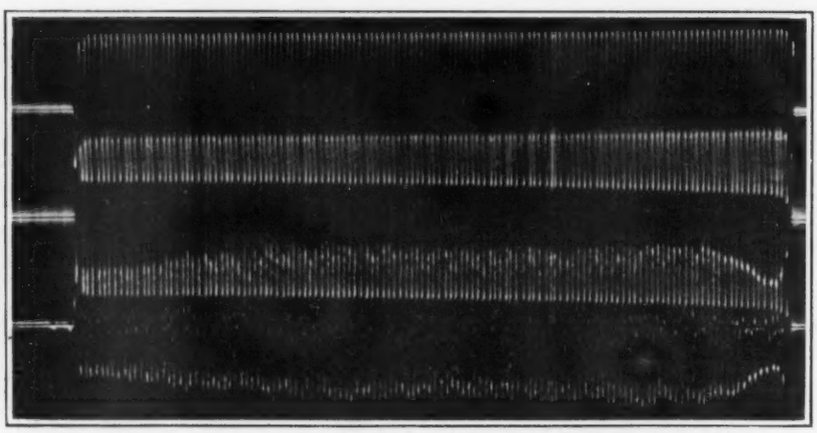


FIG. 10—OSCILLOGRAPH RECORD OF CABLE SHORT-CIRCUIT IN CONDUIT

Upper wave, phase to phase arc voltage; two lower waves, arc current on three-phase short circuit. Note that the arc voltage is first high, then drops and finally rises to a fairly steady value. This characteristic was found on all records.

An Alternating-Current Network

Philadelphia System Designed to Supply Reliable and Economical Service Over Large Areas—Primary Loop Feeders, Sectionalizing Breakers and Balanced Pilot Wire Control Used

By P. H. CHASE
Assistant Engineer Transmission and Distribution Division
Philadelphia Electric Company

THE increasing need for highly reliable service, at the same time retaining the economic advantages and operating flexibility of alternating-current distribution and utilization, has focused attention on alternating-current networks. It is now realized that alternating-current networks have widespread applications and are not limited to downtown districts in large cities, primarily because modern electric light and power service requirements can be met economically and flexibly in relatively less densely loaded areas by the alternating-current network. The establishment of an alternating-current network need not involve different types of motors and other utilization equipment, nor does it require substation equipment and distribution feeders of characteristics materially different from the radial secondary alternating-current system.

Consequently there has been a marked development of alternating-current networks in order to meet economically the widespread demand for service of a

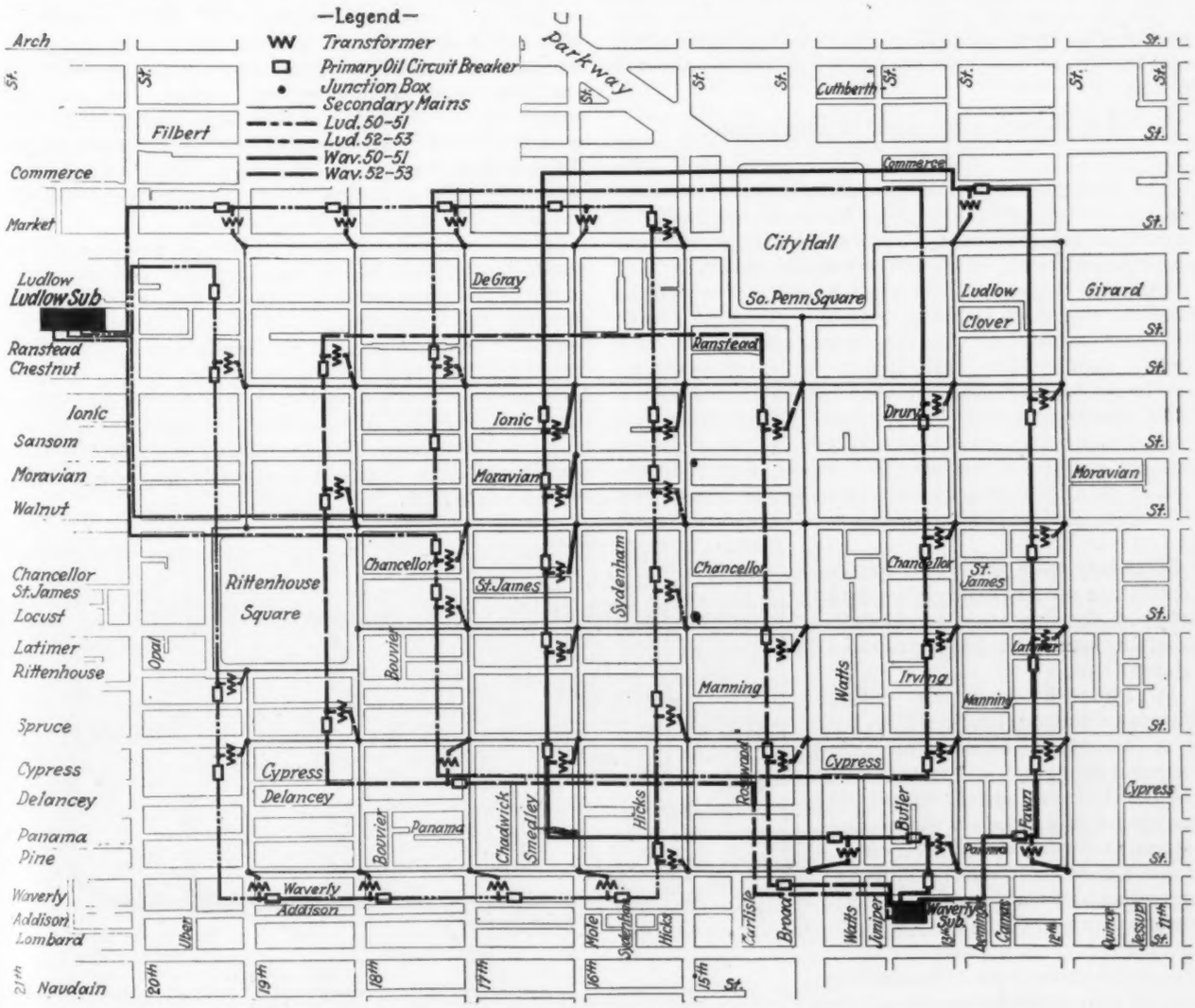


FIG. 1—LOOP PRIMARY FEEDER LAYOUT, ZONE 1

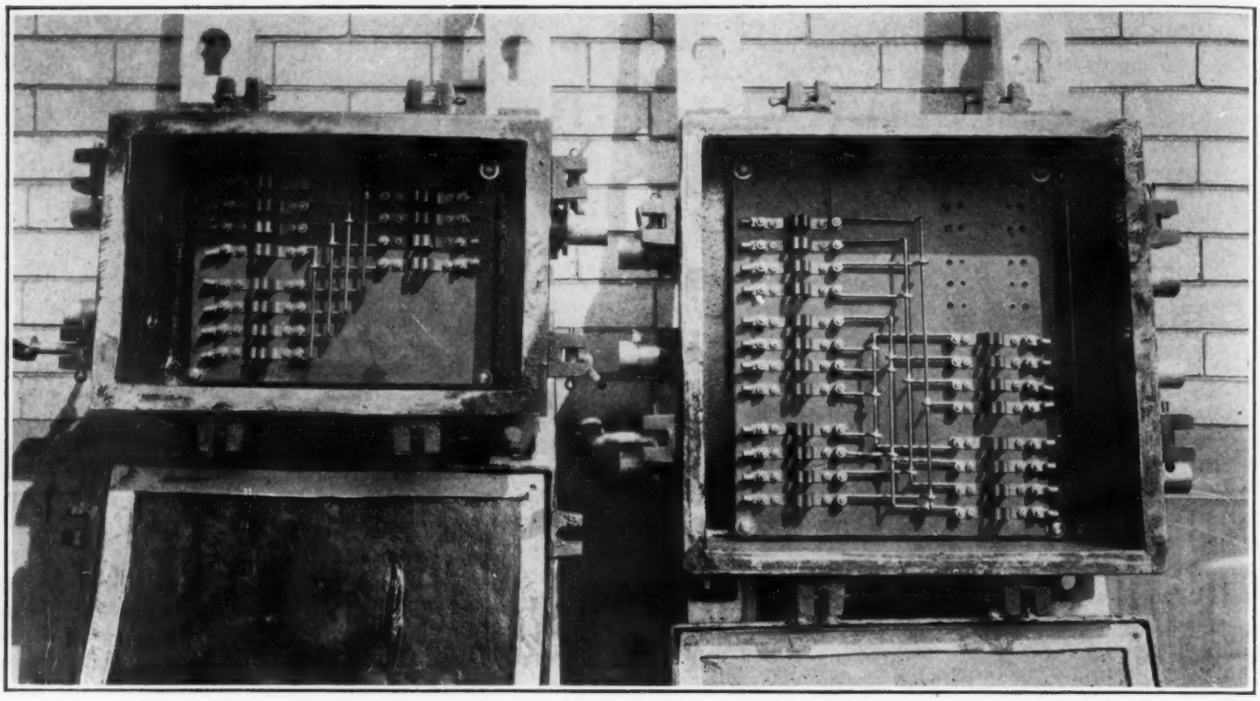


FIG. 2—"L" AND "S" BOXES

greater degree of reliability, close voltage regulation, adaptability to load growth and still retain a universal system.

A.C. NETWORK RELIABILITY AND METHODS OF PROTECTION

The problem of reliability of service from an alternating-current network centers about the method and apparatus for isolating: (1) Faulty primary feeders and transformers; (2) faulty secondary mains.

Primary feeder and transformer protection can be afforded either by isolating only the section of feeder in trouble or by isolating the entire feeder. The first method best utilizes loop feeders with sectionalizing oil circuit breakers and balanced pilot wire protection. With the second method all of the transformers on each feeder are usually connected to the network through automatic secondary switches. Group operation of these switches under reverse power is required in order to isolate the feeder in case of failure.

Secondary main protection may depend either upon burning off the fault or upon the operation of fuses in junction boxes at or near street intersections.

In Philadelphia in the central downtown section, between Vine and Pine Streets and between the Delaware and Schuylkill Rivers, originally the d.c. Edison district, there is being placed in service an alternating-current network system which includes a number of novel features of protection and construction, directed toward maximum reliability, simplicity, flexibility and economy.

Coincidentally with the establishing of the alternating-current network in the Edison district there has been a change-over of direct-current customers to alternating current and a large proportion of new load has been taken on alternating current. As a result approximately one-third of the connected load in this area is now alternating current. The distribution for this purpose was established on a radial scheme, not networked, but arranged to be readily converted as the areas are successively networked.

In the engineering study that has gone on for a number of years the various systems and types of equipment were examined in their relation to the four fundamental requirements of reliability, simplicity, flexibility and economy. It was realized that reliability, flexibility and economy in operation will be greatly influenced by the simplicity of the equipment, which must be installed at scattered locations, usually in manholes, and must operate reliably without the constant supervision that can practicably be given to substation equipment.

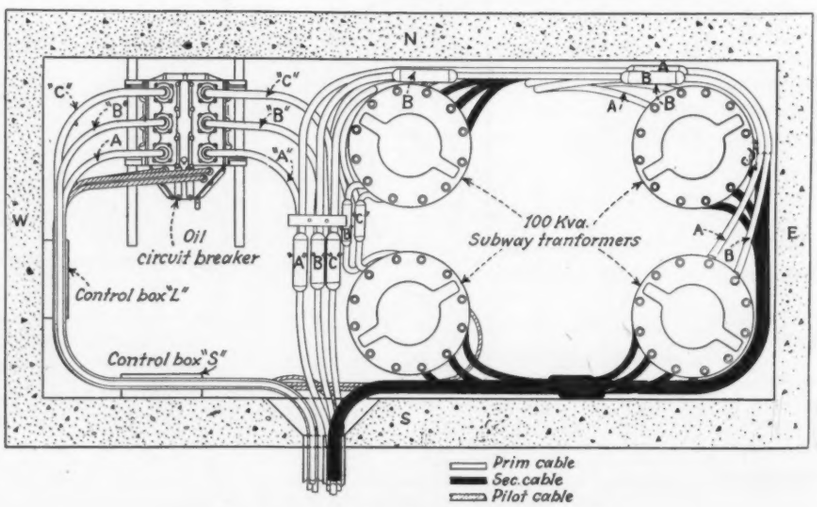


FIG. 3—PLAN OF TRANSFORMER MANHOLE

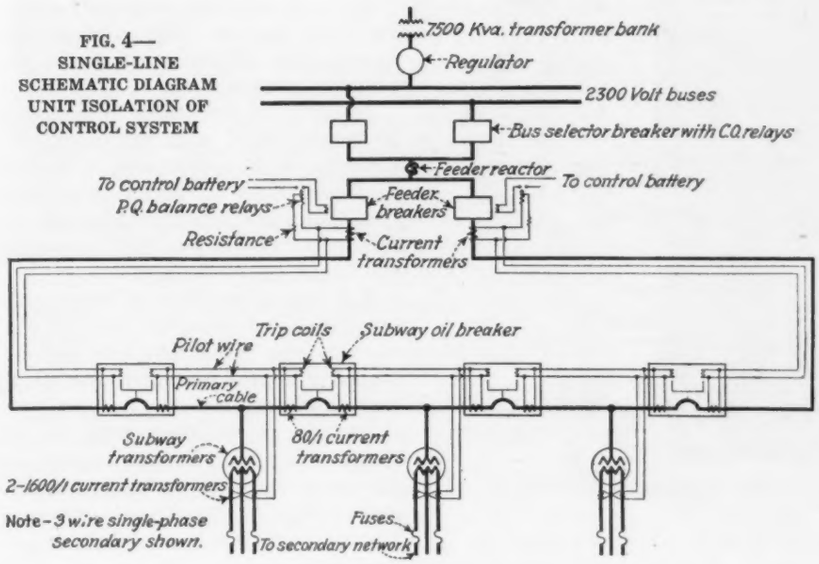


FIG. 4—SINGLE-LINE SCHEMATIC DIAGRAM UNIT ISOLATION OF CONTROL SYSTEM

The primary loop feeder system with sectionalizing oil circuit breakers and balanced pilot wire protection was selected as best meeting the requirements of reliability, simplicity, flexibility and economy.

For initial service in Zone 1, the first of six areas to be networked, there are installed four loop feeders from two substations adjacent to this area. Both ends of each feeder come from the same substation. As shown in Fig. 1, the feeders from the two substations are so interlaced that in the event of loss of supply to one substation there is sufficient feeder capacity from the other, so arranged as to provide service to the entire area. This follows from the fact that the total normal maximum load on each loop feeder is approximately one-half the aggregate capacity of the two ends of the feeder, in order to provide for the condition when trouble at one end of the feeder requires that all its load be carried from the other end.

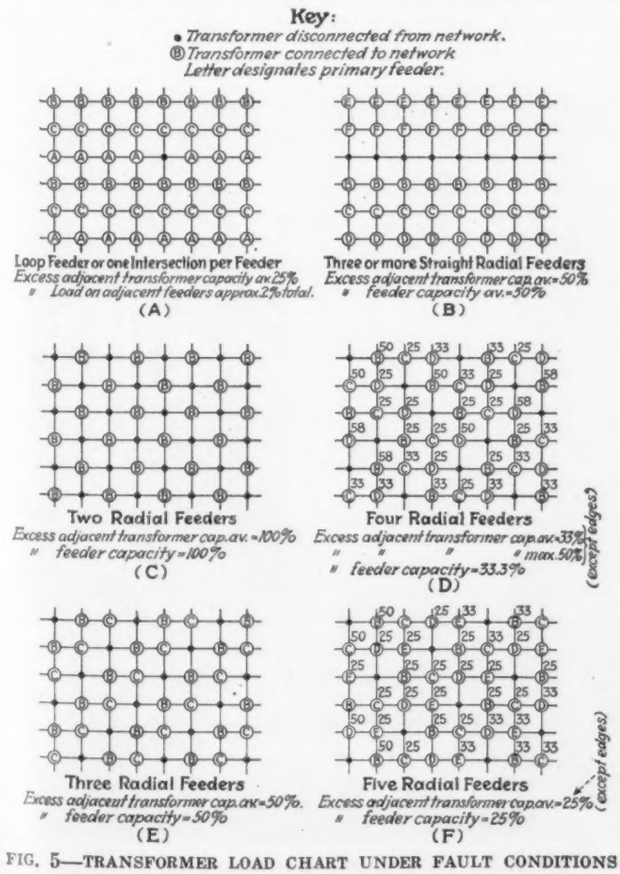

Key:
• Transformer disconnected from network.
Ⓑ Transformer connected to network
Letter designates primary feeder.
Loop Feeder or one Intersection per Feeder
Excess adjacent transformer capacity av. 25%
" Load on adjacent feeders approx. 2% total.
(A)
Three or more Straight Radial Feeders
Excess adjacent transformer cap. av. = 50%
" feeder capacity av. = 50%
(B)
Two Radial Feeders
Excess adjacent transformer cap. av. = 100%
" feeder capacity = 100%
(C)
Four Radial Feeders
Excess adjacent transformer cap. av. = 33%
" " " " max. 50%
" feeder capacity = 33.3%
(D)
(except edges)
Three Radial Feeders
Excess adjacent transformer cap. av. = 50%.
" feeder capacity = 50%
(E)
Five Radial Feeders
Excess adjacent transformer cap. av. = 25%
" feeder capacity = 25%
(F)
(except edges)

FIG. 5—TRANSFORMER LOAD CHART UNDER FAULT CONDITIONS

UNIT SECTIONS

Each loop feeder is made up of a number of sections connected by subway type oil circuit breakers. The transformers at the various street intersections are tapped directly to the primary feeder section at that point and are connected to the secondary network through copper link fuses. As the transformers and associated feeder section are treated in the protective system as a unit, this scheme may be called the "unit-section" system. One of the important economic results of the unit-section system is to minimize the number of primary circuit breakers as compared with other loop schemes which do not protect and isolate the transformers as a unit with the feeder section. This unit idea is also carried out in the construction in order to afford maximum reliability and safety.

BALANCE PROTECTIVE METHOD

Fig. 10 shows schematically the method of protection for a loop feeder. Each unit section is protected by pilot wires connecting current transformers and trip coils in the circuit breakers adjacent to the two ends of the feeder section and current transformers on the secondary side of the associated step-down transformers. The number of circuit breakers is reduced to a minimum by having each circuit breaker serve to isolate either unit section adjacent to it, in case of a predetermined disturbance of the normal balance in the pilot wire system, resulting from a fault in that section.

The protective system for each unit section is responsive only to faulty conditions within that section and is independent of direction of power flow, voltage, power factor or time. This protection includes in its sphere the transformer as well as the primary feeder section. In the event of a fault anywhere in a unit section the relative reversal of power results in the bucking of the current transformers and the tripping of the circuit breakers at the two primary ends of the unit section. The back feed from the network blows the secondary transformer fuses, and the unit section is isolated.

ADVANTAGES OF UNIT-SECTION SCHEME

As only the faulty unit section is isolated, there is a minimum additional load thrown on adjacent transformers. Consequently the routing of the primary feeders is simplified or the reserve capacity of the distribution transformers is decreased, as compared with systems requiring the group isolation of all the transformers on a feeder in case of failure at any point on it. Under uniform loading conditions in a network area the isolation of the transformers at one street intersection will result in almost 25 per cent increase in load on each of the four transformers at the adjacent intersections. The transformers farther away pick up

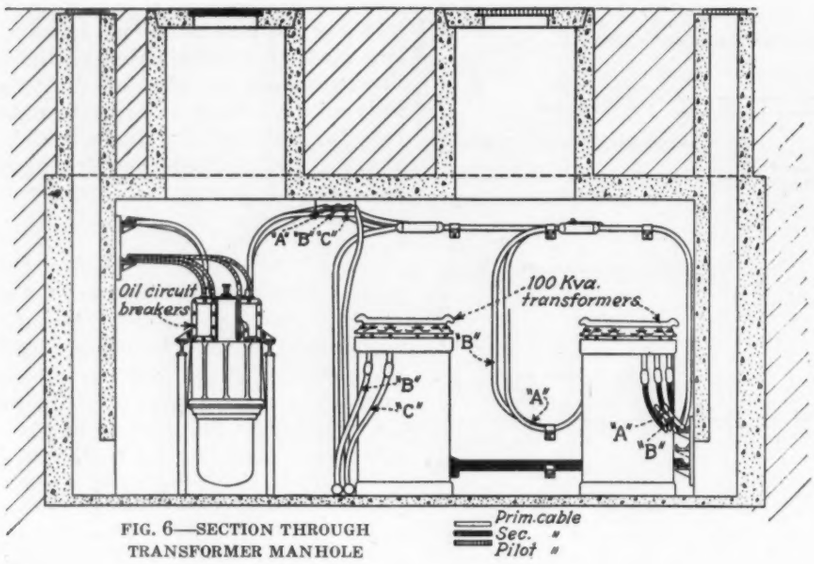


FIG. 6—SECTION THROUGH TRANSFORMER MANHOLE

little load because of the impedance of the mains. This is shown in Fig. 5 (A), and demonstrates one of the main advantages of loop feeders for networks. It is apparent from Fig. 5 (B), (C), (D), (E) and (F), that non-sectionalized feeders require either considerable excess transformer capacity, wide "interlacing" of the primary feeders to reach non-adjacent transformer locations or only a few intersections per feeder. It was found that the superiority of the sectionalized loop system in these respects was reflected in economic savings at least balancing the added costs in pilot cable and substation equipment.

The utilization of the balance principle in protecting the unit sections has a number of advantages which satisfy the requirements of reliability, simplicity and flexibility:

The inherent discriminatory action involved isolates only the section having the faulty unit from the primary system.

Isolation of the faulty unit section is accomplished with minimum disturbance to the system and to service, as there is no purposely introduced time delay and a relatively small unbalance current is required to operate the breakers.

The rupturing duty on the circuit breakers is "single-shot" and is lightened by the inherently low current required for the protective system to function.

The circuit breakers need not be closed in against a short circuit, as all testing for locating faulty primary cable is made from the network side. This further lightens the duty on the breakers.

There are no relays or moving contacts in the control circuits.

No automatic reclosing equipment is required on the circuit breakers, as all the other unit sections except the faulty section remain energized. After tests and repairs are made the subway circuit breakers adjacent to this unit section are closed by hand.

MANHOLE INSTALLATIONS AND EQUIPMENT

Figs. 9 and 11 show views of a typical manhole, in which are installed one subway type primary oil circuit breaker, subway transformers and control boxes. A plan view is shown in Fig. 3.

The transformer manholes are located as near as practicable to the street intersection they supply and in most locations provide space for the ultimate

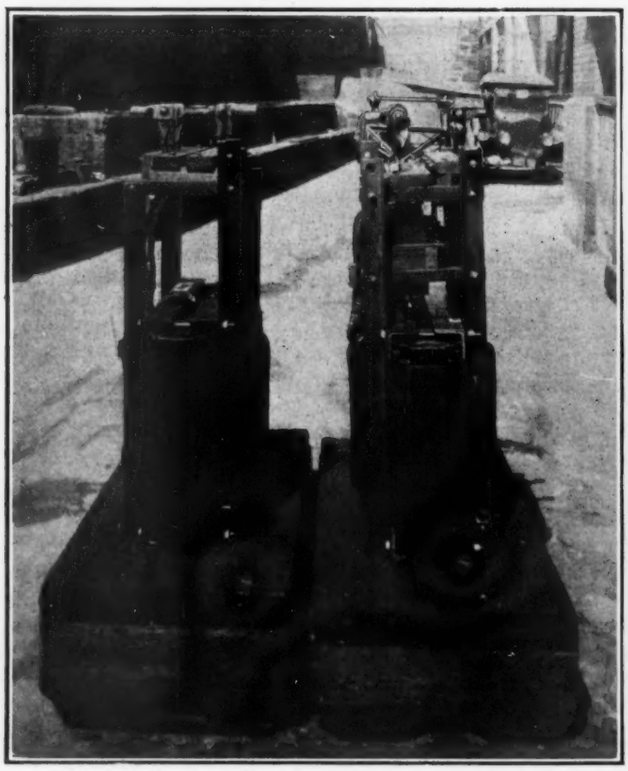


FIG. 7—SUBWAY TRANSFORMER CORE WITH C.T.

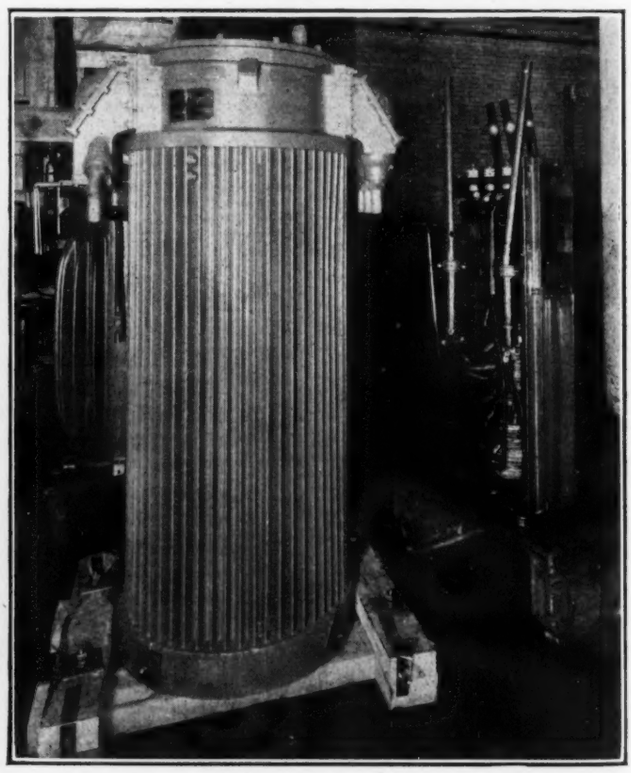


FIG. 8—13,800/2,300 TO 115/230-VOLT TRANSFORMER

installation of four 100-kva. units. Fig. 6 is a section through a typical manhole and shows the removable slabs containing the access openings, and the air intake ducts to the bottom of the manhole. Gratings over these ducts and the access openings provide sufficient ventilation for this amount of capacity.

Where subsurface conditions require, the oil circuit breaker and control boxes are installed in a manhole separate from the transformer manhole. Similarly, the secondary fuse boxes sometimes are installed in another manhole or use is made of existing street junction boxes installed originally for the direct-current Edison system.

Subway Oil Circuit Breakers

The oil circuit breakers now installed are rated for 15,000-volt service and comprise spring-suspended phase tanks mounted within a cast-steel housing, with a large expansion chamber below, which are constructed for subway installation. The six leads to the circuit-breaker are 350,000-c.m. single-conductor cable, each of which passes through a separate current-transformer well, below which the cable sheath terminates with a slitted copper end bell. The insulated conductor passes down through the switch bushing to a lug connecting to the contact block. There are provisions for this lead assembly in the field without disturbing the switch adjustments and for filling the bushing, end bell and current-transformer well. Voltage tests have shown a very high factor of safety with this isolated phase construction.

There are six trip coils, three under each vertical cover plate to the sides of the operating handle. The mechanism trips free from the handle, which can be blocked and padlocked in the closed or open position. An indicator actuated by the mechanism shows the position of the switch.

When once installed, no circuit breaker changes are necessary to change the capacity of the transformer bank, to rearrange the primary feeders or to install additional circuit breakers to create another unit section.

Subway Transformers

In Zone 1 the transformers are standard 100-kva. subway type units 2,300 to 115/230, three-wire, 3.5 per cent impedance, with a 1,600/1 ratio current transformer mounted inside the case in each of the two outside secondary leads. These are cross-connected and afford the proper ratio and protection for the three-wire single-phase and five-wire two-phase secondary connection. Fig. 7 illustrates the method of mounting. In Zone 2 the transformers are 100-kva. subway type 13,800/2,300 to 115/230-volt, three-wire, 5 per cent impedance with the same type and ratio current transformers. These transformers have six primary coils, which initially are connected in parallel for 2,300 volts. The units are provided with detachable wiping end bells on both primary and secondary sides (Fig. 8), so that installation and replacement can be made without breaking the seal of the transformer proper. On the 13,800-volt connection there are tap changers for 5 and 10 per cent reduced voltage and Scott taps for three-phase to two-phase transformation.

The self-contained current transformers are included in these two types of units without change in the size of the transformer tanks, at little additional expense, and without any appreciable effect on the heating.

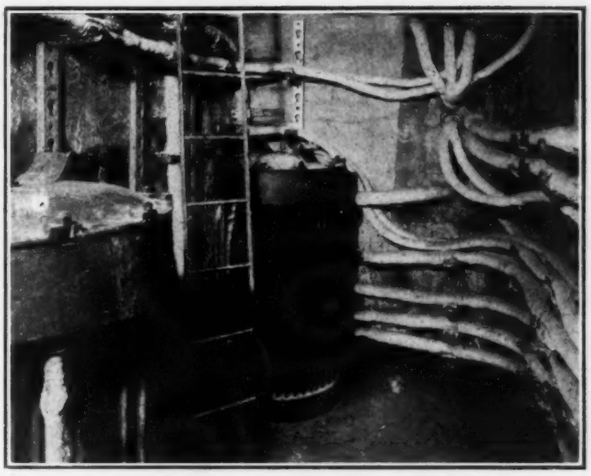


FIG. 9—VIEW OF TRANSFORMER MANHOLE

There is provided a wiping bushing on the low-tension side for the control cable connection to the current transformers.

Control Boxes

Fig. 2 illustrates the two control boxes for each unit section. The "L" box is located in the manhole containing the oil circuit breaker near the transformers associated with that section and the "S" box is located in the manhole at the other end of that unit section. Panels in these control boxes mount test clips and buses which serve to junction the control cables from the current transformers, trip coils and control box at an adjacent intersection. The clips provide for routine testing of the control cables and equipment for open circuits, short circuits and grounds; also the trip coils may be calibrated, current transformers tested and the load on transformers and feeders measured.

Isolation of Protective Equipment

The unit principle has been followed in the construction of the control system by isolation into unit sections, in order to afford maximum reliability. This is shown schematically in Fig. 4. The pilot cable, four-conductor, No. 4 stranded rubber-lead, parallels the feeder cable for that section and connects between the "L" box and the "S" box associated with it. In the circuit breakers the two sets of trip coils are in separate compartments and the current transformers and connections for each side of the breaker are separated, because the equipment on each side of the breaker is associated with different unit sections. Therefore there is a separation and isolation of the control system for each unit section. The effects of failure of equipment, entrance of foreign current and mistakes

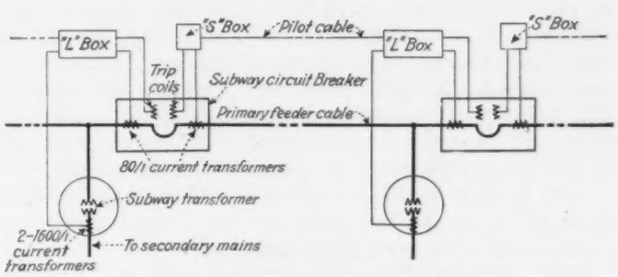


FIG. 10—SINGLE-LINE SCHEMATIC DIAGRAM PILOT WIRE PROTECTIVE SYSTEM

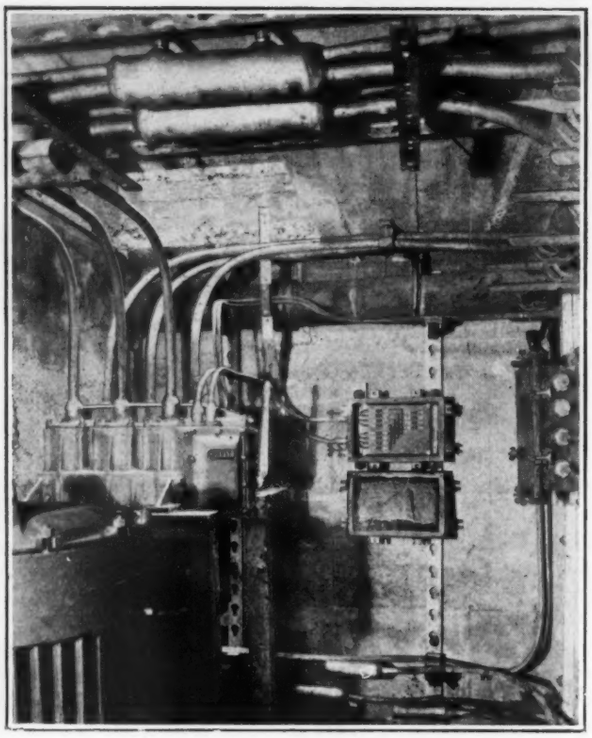


FIG. 11—ANOTHER VIEW OF TRANSFORMER MANHOLE

will be closely localized. The control system for each unit section is grounded in the "L" box associated with that section.

MANHOLE SECONDARY JUNCTION BOXES

Five-way, single polarity manhole type secondary junction boxes, of the type illustrated in Fig. 12, have been standardized upon. Each provides for one 1,000,-000-c.m. transformer cable and four 350,000-c.m. main cables. Copper link fuses are installed in each branch, and sockets are provided so that each branch can be tested and re-fused by means of a portable fused switch outfit. This provision allows all tests for locating defective primary cable and equipment to be made from the secondary side. Reclosing of the primary circuit breakers against short circuits is thereby avoided. Existing street junction boxes installed for the direct-current system in this area are also being utilized where expedient.

SECONDARY FUSES

Extensive tests on copper link type fuses have led to the conclusion that by the use of fuses selected for operation under fault conditions, one rating for mains and a higher rating for transformers, a high degree of selective operation will be secured under the conditions obtaining on this network. The ratings are determined primarily for operation under short-circuit conditions rather than overload. The use of fuses on the mains was decided upon in preference to tying-in solid and depending upon burning off faults, because of the large amount of tube mains still in service, the extended use of multiple conductor cable and the greater insurance afforded by fuses against extensive damage in the event of a cable main failure

Fuses, instead of more complicated equipment for isolating the faulty unit sections from the network, afford a high degree of reliability. The use of fuses alone for this purpose is most practicable where there is highly selective, individualized protection such as in the unit-section system used.

SUBSTATION FACILITIES

Each substation has two sectionalized 2,300-volt buses forming four bus sections, each section separately fed from a 7,500-kva. transformer bank but supplied from the same generating station.

Each end of the loop feeders is provided with automatic oil circuit breakers, and the complete loop may select either of the 2,300-volt buses by a pair of automatic selector oil circuit breakers. One per cent reactors are installed between these two groups of oil circuit breakers. (See Fig. 10.)

A large two-phase regulator on the 2,300-volt side of each transformer bank provides group regulation for all the feeders on one bus section. Under temporary conditions single-phase regulators with mechanical connection are installed on the individual feeders.

The feeder circuit breakers are actuated by PQ balance relays, which are associated with the current transformers at the substation end of the feeder section and the current transformers and trip coils in the first subway breaker, as shown in Fig. 10. Each PQ relay has a resistance in series with it to give the same total impedance as that of the trip coils in the first circuit breaker on the loop. The automatic selector circuit breakers are provided with CO time delay relays to provide against failure of the reactors and as "back-up" in case of failure of the loop differential protection. Adhering to the same substation design as has been used for radial feeders, the space taken by a loop feeder is no greater than that required for a radial feeder.

CONTROL SYSTEM DESIGN

In the design of the control system the ratio and characteristics of the current transformers, the impedance and tripping current of the trip coils and the size and length of the pilot cables required considerable engineering study in order to afford reliability and sensitivity of operation in case of a fault within the unit section and yet to retain an ample margin for non-operation of the trip coils with the various combinations of through faults. It was found that the saturation of the current transformers under heavy currents was of assistance rather than a detriment.

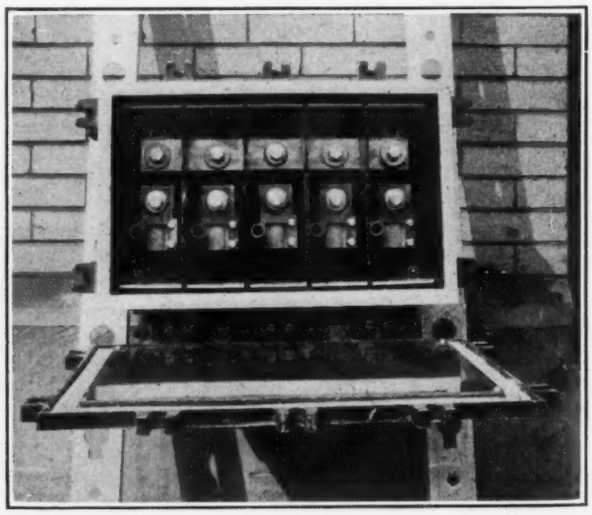


FIG. 12—FIVE-WAY MANHOLE JUNCTION BOXES

In the study of the network system it was found necessary to predetermine accurately the loads, voltages, etc., under a number of conditions that were not susceptible of accurate or quick determination by calculation. Therefore there has been constructed a single-phase, alternating-current calculating table on which can be set up various feeder, transformer and main combinations, with impedances and loads accurately reproduced, and measurements taken. This has been of great value in the study of the general and detail problems in connection with the change-over from direct current, routing of feeders, primary supply to substations and transformer capacity.

Standard arrangements of the phase leads into the circuit breakers, connections to and within the control boxes and uniform sequence of connection of the transformers have been rigidly adhered to throughout the installation. A preferred arrangement of equipment and wiring has been followed except where modifications were dictated by sub-surface conditions. A tagging scheme for primary and secondary cables identifies the feeders, secondary mains and transformer leads.

Flexibility and Load Growth

The unit-section system has a high degree of flexibility in meeting varying conditions and in providing for growth. The two-phase, five-wire secondary system* also contributes to such flexibility, particularly in conjunction with the direct current to alternating current changeover which is proceeding in parallel with the establishment of the alternating-current network.

The transformer capacity at an intersection can be increased or reduced without any change to the primary circuit breakers, secondary fuse boxes or control system.

Separate banks of transformers may be installed, with separate mains, in order to meet special service conditions, by merely connecting the self-contained current transformers to the control system through the "L" control box, in case it is not desired to install another circuit breaker and thus establish a new unit section.

The initial installation at many intersections is single-phase 115/230 volts. The second phase is added by the installation of the second transformer and the necessary junction boxes.

Primary service can be rendered from a unit-section loop feeder with high reliability and flexibility, due to the two-direction, reserve-capacity feed and the selective protective system.

Provisions for Future 13,200-Volt Primary Feeder Supply

Although the present primary feeder supply is 2,300 volts, two-phase, three-wire, provision has been made throughout for future three-phase, 13,200-volt primary. Practically all of the feeder cable is three-conductor 350,000-c.m., 13,200-volt cable and the oil circuit breakers are rated for 15,000-volt service. Provisions have been made in the control boxes, by extra wiping bushings and space for future clips and terminals, for the connection of cascade current transformers of approximately 6 to 1 ratio with three-phase to two-phase taps. At that time replacement of 2,300-volt transformers in Zone 1 and reconnection of 13,800/2,300-volt transformers in Zone 2 will be required. The current transformers in the oil circuit breakers and transformers will remain unchanged.

*See *A.I.E.E. Journal*, August, 1925, "Engineering and Economic Elements of Two-Phase, Five-Wire Secondary Distribution," P. H. Chase.

Operating Reliability

The reliability and quality of service from an alternating-current network is measured by the effect (1) of a secondary main fault, (2) of a primary feeder and transformer fault, (3) of a failure of supply to a substation or to a substation bus.

A secondary main fault will affect all the customers on that main. There may be fluctuating voltage during the burning off of a fault in case the mains are tied in solid, or there may be a partial or complete interruption in case the mains are fused, depending upon whether there is a conductor-to-ground or a conductor-to-conductor fault. At any rate only the customers on the faulty main are likely to be seriously affected by the outage.

A primary feeder or transformer fault requires the isolation of at least the portion of the feeder and transformer in trouble and requires the remaining feeders and adjacent transformers and mains to have sufficient reserve capacity to carry the load normally carried by the isolated transformers until the fault is located, repairs and tests made and normal operation resumed. The time involved is a matter of hours and the condition may continue over the load peak. Therefore it is essential that the feeder layout and the reserve feeder, transformer and main capacities be adequate to provide for this long-time contingency, with due regard to economic considerations. It was concluded that the "unit-section" loop system best met these requirements most economically, due to the close localization of the isolated feeder section and transformer in trouble, with consequent minimization of excess transformer and main capacity. The saving in primary feeder cable also results from the direct routing of the cable made possible with the balance protective system.

Basis Upon Which Reliability of Service to Customers Is Determined

A failure of supply to a substation or to a substation bus is considered a matter of minutes rather than hours, and the reliability and quality of service to customers in such a contingency are determined by the short-time rating of the feeders into and out of the substations which still are feeding the system and by the voltage drops in feeders, transformers and power mains.

From a service point of view it is desirable to have at such a time the maximum possible feeder capacity in service in order to reduce the loading and voltage drop on feeders, transformers and mains. The "unit section" loop feeder system, which affords 100 per cent reserve feeder capacity and is not operative by voltage or direction of power flow, meets this requirement. Investigations of such conditions on the alternating-current calculating table show that with the entire feeder system connected in during a failure of substation supply there is a pronounced reversal of power at many points. This serves, by back-feed through various primary feeders, to maintain voltages and reduce the load which would be thrown upon many of the transformers and mains if the points of connection to the network were through switches opened by reversal of power.

Organization
the Key to Successful Steam Plant Construction

By W. N. PATTEN
Vice-President Division of Construction and Engineering
Stone & Webster, Inc., Boston, Mass.

DURING the last few years the size of power plants has increased very materially and where fifteen to twenty years ago we discussed plant capacities of 10,000 to 15,000 hp., we are now considering plants of from 500,000 to 1,000,000 hp. This very rapid increase in the size and importance of power plants has necessarily introduced new methods in construction and has called for facilities and organization to produce in approximately the same time period these larger plants, as compared with those of lesser capacity.

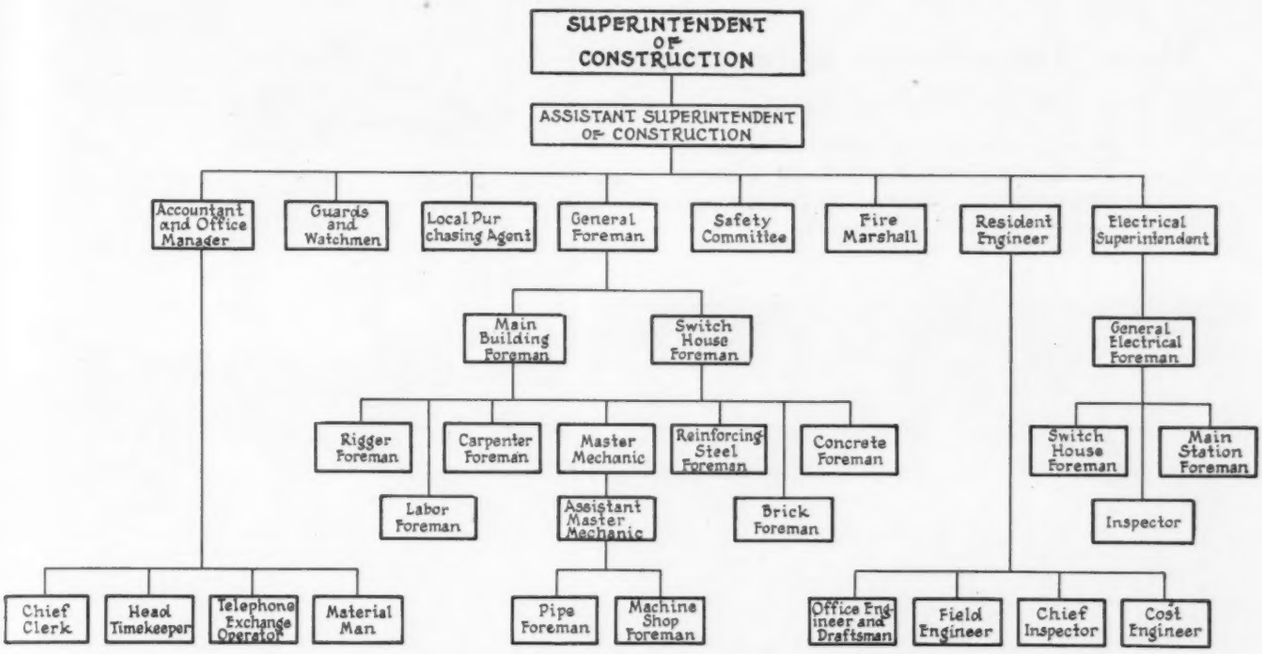
In considering the factors that have contributed most to the accomplishment of this result, it must be admitted that organization and personnel have been more effective than improvements in mechanical appliances for doing the work. Various tools and appliances have been perfected and introduced on construction operations, which have materially aided in making rapid progress, and the greater use of electricity and gasoline-driven equipment has been a very considerable factor in serving these ends. Concrete placing equipment has also been greatly improved and perfected and the use of the hoist tower with its complement of chutes has greatly facilitated the distribution and placing of concrete over large areas and in high structures. Man power, however, still supplies most of the effort required in the construction of a power plant, and it is this power, adequately and intelligently directed, that in a large measure is responsible for the marvelous records that have been made in the construction of large power plants during the past few years.

The most important factor in the execution of any large construction operation is the planning of the work before a spade is stuck in the ground. It might almost be said that 90 per cent of the success of any job is the paper planning that is done in the office before the construction force takes the field.

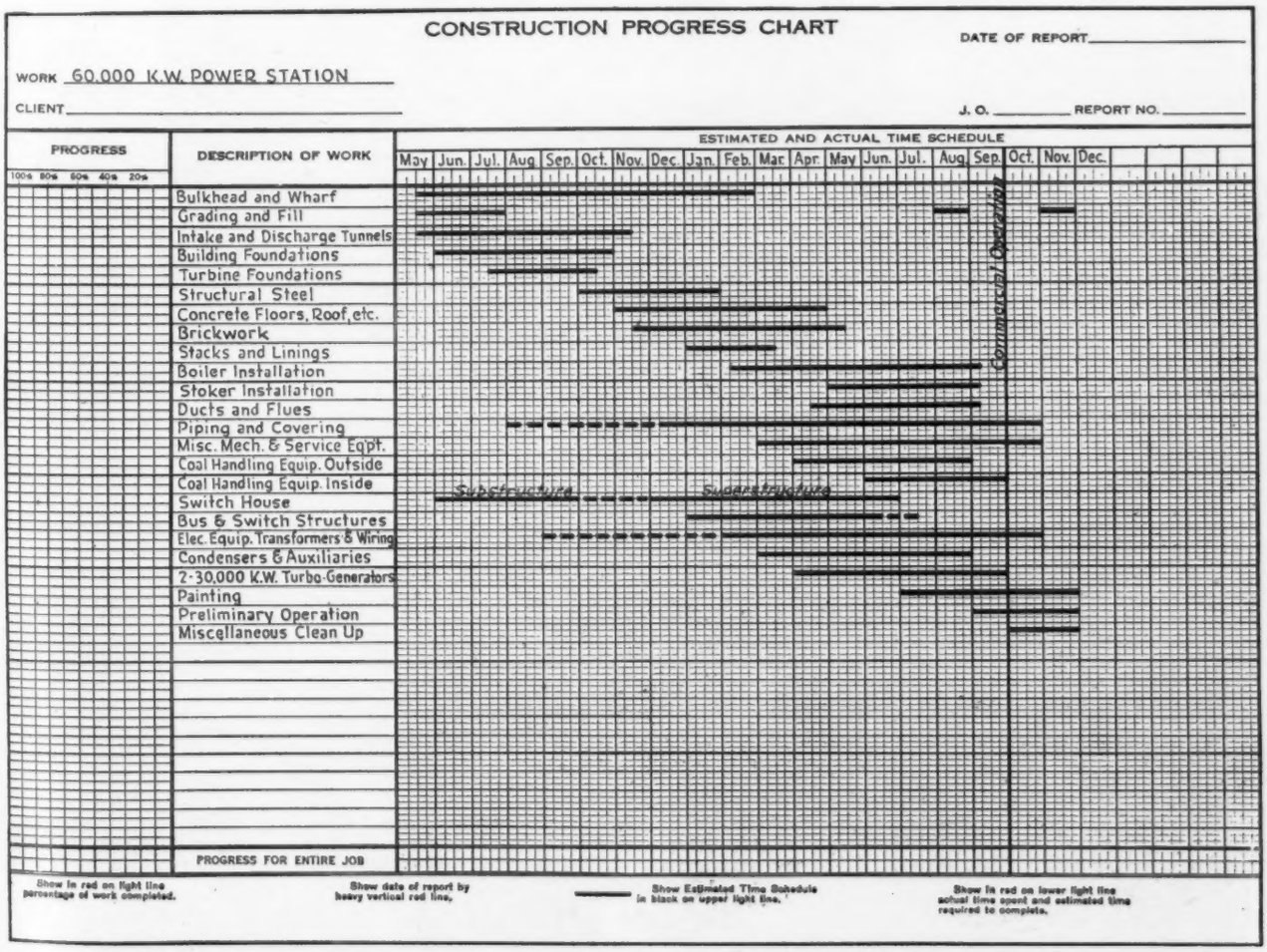
Next in importance to the planning of the job is the selection of the personnel for carrying through all parts of the project from the preparation of the preliminary sketches to the starting up and operation of the plant. This selection calls for a thorough knowledge of human nature and accurate judgment as to the adaptability of men to meet the special conditions that occur on every construction undertaking. With a large organization to draw from, the executives are able to select men who are especially qualified in each main branch of the work, such as design, construction, purchasing and accounting, and then in co-operation with these division heads to select the personnel required for completely rounding out the organization.

With the organization selected and the paper planning well in hand, the next important function is to prepare a schedule of progress that will indicate for the major items of the construction operation the time periods that may be allowed in order that the project as a whole may be completed on a given date. This progress schedule is further subdivided into detail operations that are carefully studied and the entire program timed to meet the delivery dates for the major items of operating equipment. The preparation of the progress schedule under functional divisions of the work permits ready analysis of the man power required, and this, together with delivery dates on equipment and contract terms for payment, allows of estimating with reasonable exactness the cash requirements for the full construction period.

It is perfectly obvious that with the job properly scheduled as to progress from the preparation of drawings to the installation and starting up of equipment, nothing is left to chance and each detail of the job is well in hand and under control at all times. With reasonable regard for economy and efficiency, it is possible to plan the work to meet a definite date for completion and the more keenly and accurately each function is studied and analyzed the more certain are the results that will be obtained. It is also possible to plan the progress of construction work to take the greatest advantage of seasonal variations in our climate, those operations that can be most efficiently done in milder weather being planned accordingly and those that can be done during the colder weather being scheduled on this basis.



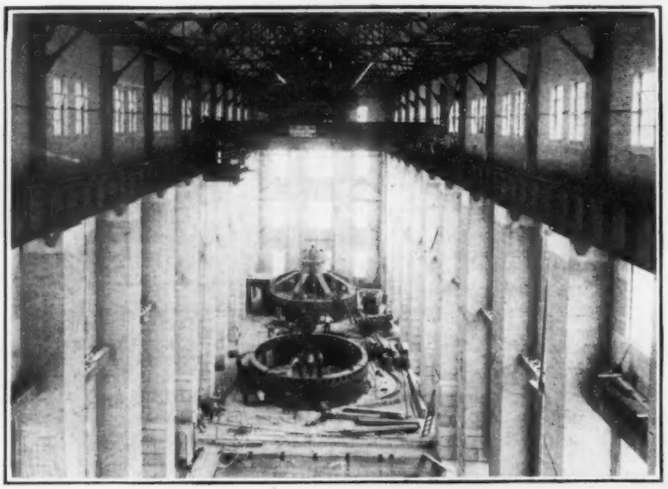
The organization indicated above is typical for power plant construction in capacities of 60,000 kw. and above. For plants of smaller capacities the same scheme of organization holds, but various functions might be combined under a single foreman or department

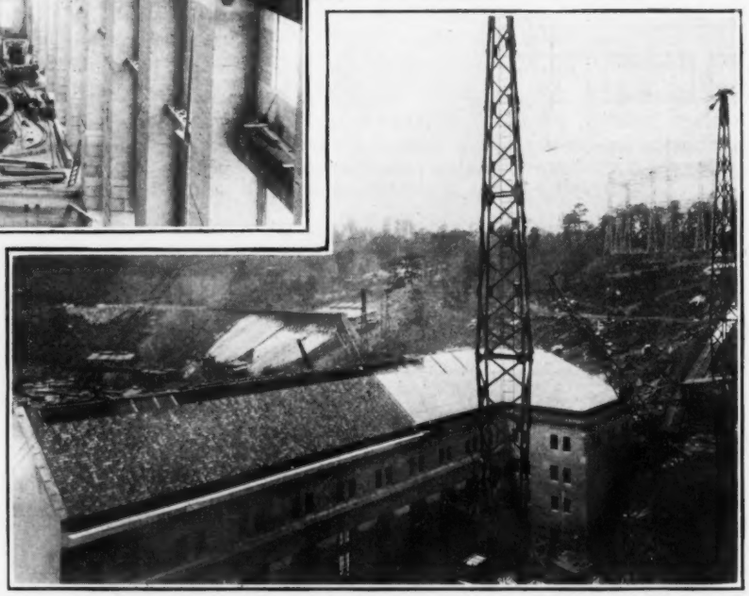

CONSTRUCTION PROGRESS CHART
DATE OF REPORT
WORK 60,000 K.W. POWER STATION
CLIENT
J. O. REPORT NO.
PROGRESS
100% 80% 60% 40% 20%
DESCRIPTION OF WORK
ESTIMATED AND ACTUAL TIME SCHEDULE
May Jun. Jul. Aug Sep. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May Jun. Jul. Aug. Sep. Oct. Nov. Dec.
Bulkhead and Wharf
Grading and Fill
Intake and Discharge Tunnels
Building Foundations
Turbine Foundations
Structural Steel
Concrete Floors, Roof, etc.
Brickwork
Stacks and Linings
Boiler Installation
Stoker Installation
Ducts and Flues
Piping and Covering
Misc. Mech. & Service Eqpt.
Coal Handling Equip. Outside
Coal Handling Equip. Inside
Switch House
Substructure
Superstructure
Bus & Switch Structures
Elec. Equip. Transformers & Wiring
Condensers & Auxiliaries
2-30,000 K.W. Turbo-Generators
Painting
Preliminary Operation
Commercial Operation
Miscellaneous Clean Up
PROGRESS FOR ENTIRE JOB
Show in red on light line percentage of work completed.
Show date of report by heavy vertical red line.
Show Estimated Time Schedule in black on upper light line.
Show in red on lower light line actual time spent and estimated time required to complete.

The construction progress chart reproduced above covers the main subdivisions for a 60,000-kw. power plant. Additional sheets would be prepared covering detail operations. The chart is revised periodically and the percentages of work performed are indicated for each revision

Major Hydro-Electric Development on Tallapoosa River

A few construction views of work on Martin Dam, the 112,500-kva. hydro-electric project of the Alabama Power Company at Cherokee Bluffs



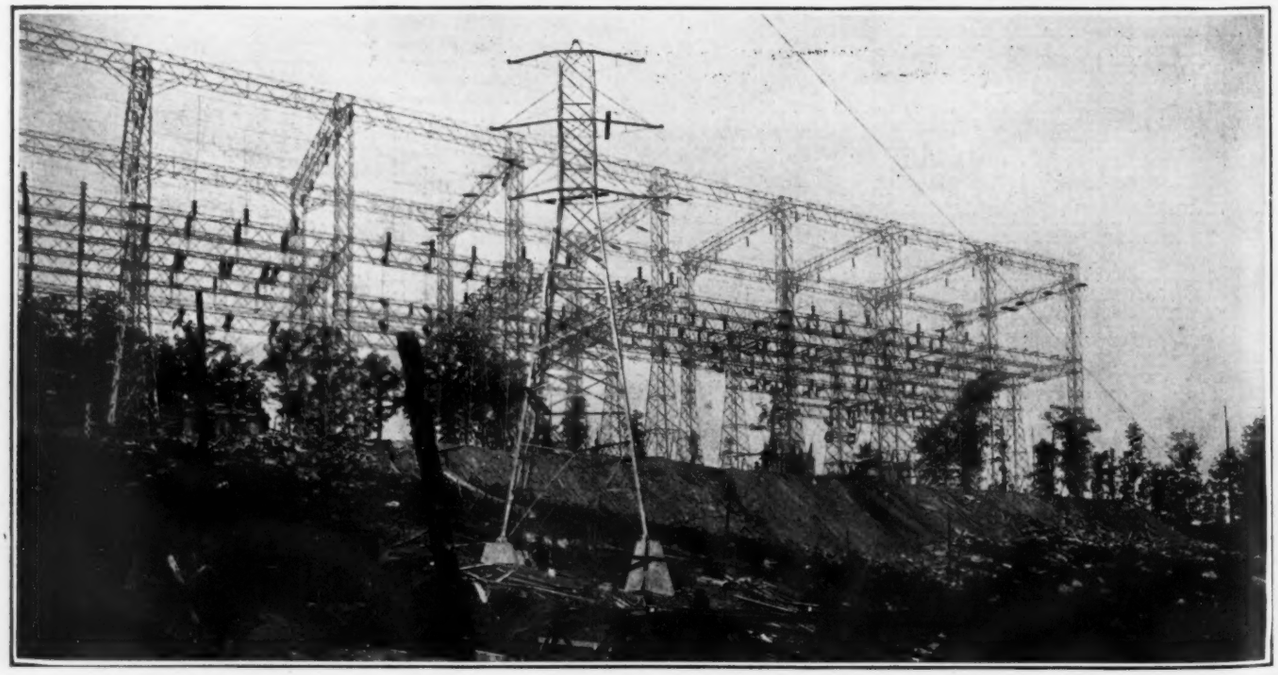


ABOVE—INTERIOR OF 112,500-KVA. HYDRO PLANT AT CHEROKEE BLUFFS IN ALABAMA

TOP, RIGHT—FORTY-TON SPILLWAY DECK CRANE

CENTER—POWER HOUSE AND CONDUIT RUN TO SUBSTATION

BELOW — TRANSMISSION TOWER AND SUBSTATION

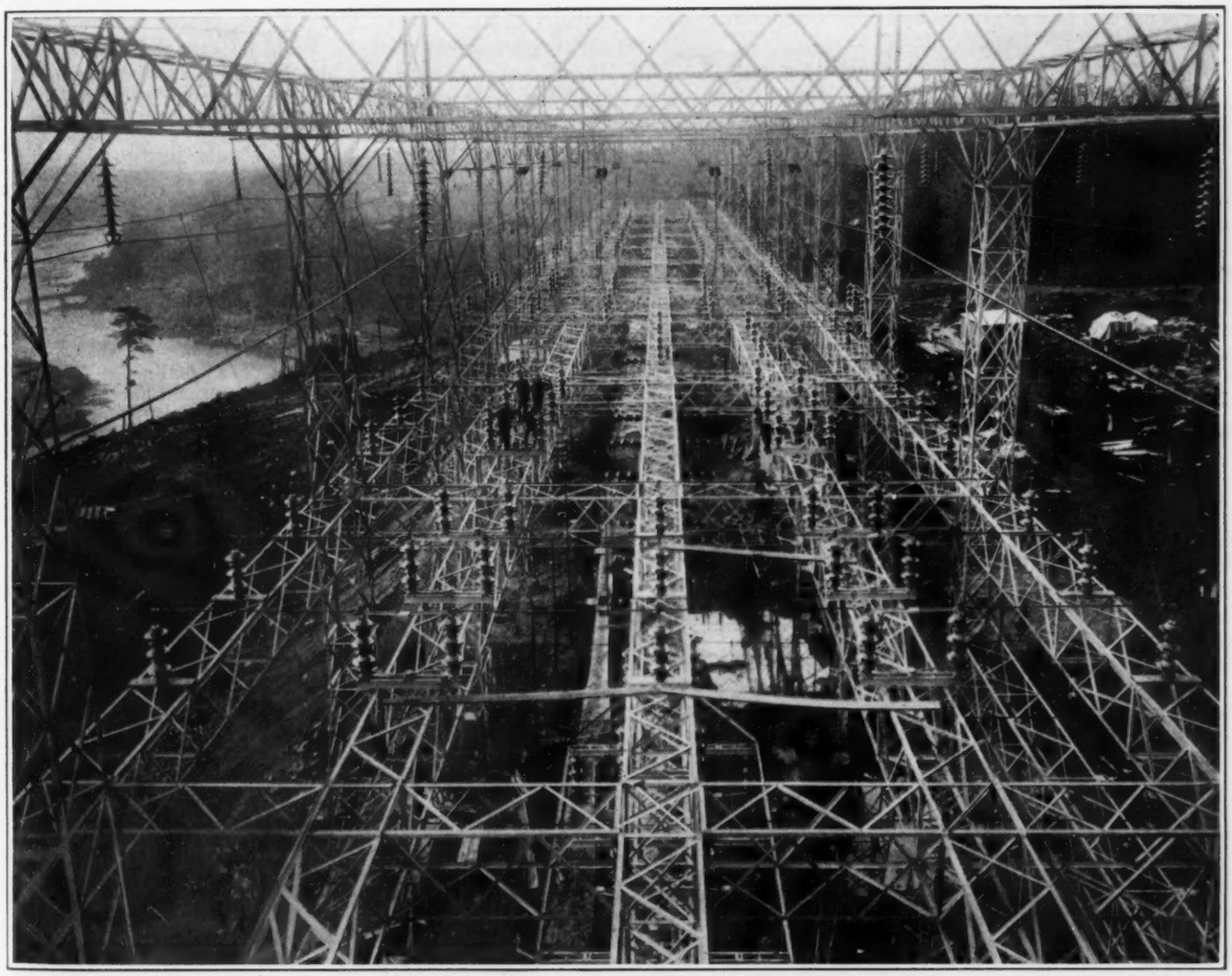


Construction Features of Martin Dam

Hydro-Electric Development of Alabama Power Company at Cherokee Bluffs on the Tallapoosa River Described in Detail—Present Capacity 112,500 Kva. with Ultimate of 150,000 Kva.

By L. G. Warren

Assistant Superintendent in Charge of Field Engineering
Alabama Power Company, Birmingham, Ala.



SUBSTATION AT MARTIN DAM IS 654 FT. LONG AND 80 FT. WIDE

THE Alabama Power Company is just completing a 112,500-kva. hydro-electric development at Cherokee Bluffs, on the Tallapoosa River about 42 miles northeast of Montgomery, Ala. This project is known as Martin Dam in honor of Thomas W. Martin, president of the Alabama Power Company and of the Southeastern Power & Light Company. Martin Dam is the major development of a series proposed on the Tallapoosa River. There are two plants immediately below Cherokee Bluffs, known as Upper and Lower Tallassee, which the company plans to reconstruct upon the completion of Martin Dam to utilize more fully the full fall of the river in this section. Upper Tallassee, which now has a head of 34 ft., will be changed to 60 ft. with a generating capacity of about 50,000 kw., whereas Lower Tallassee, with a present head of 60 ft., will have a head of 87 ft. and a capacity of about 70,000 kw. Martin Dam is primarily a storage proposition as contrasted to the company's run-of-river plants on the Coosa River at Lock 12 and Mitchell Dam and of Lock 18, which is now under construction.

Martin Dam, as constructed, forms a lake of 39,400

acres with a capacity of about 60,000,000,000 cu.ft. available storage. Due to its very irregular shape, the perimeter of the lake with full reservoir is approximately 700 miles. With a 60-ft. drawdown the equivalent storage capacity of the lake is about 150,000,000 kw.-hr. This available storage under normal operating conditions will make available the regulated flow of the Tallapoosa River of 3,260 sec.ft., this flow being utilized at Upper and Lower Tallassee also.

The entire development comprised seven major subdivisions: The clearing of reservoir basin, construction of spillway sections, headworks of power house, retaining section on west shore, earth dike on east shore, power house and substation.

The station is shaped in the form of the letter L, the three generating units being located in the main body of the structure, whereas the machine shop, battery room, remote control board, pumps and compressors and offices are situated in the base of the L.

Each machine is a complete generating unit, having its own direct-connected exciter, separate station service transformer and bus layout. In case of failure of a direct-connected exciter, a spare exciter is provided, which is motor driven and is connected so that it can be switched almost instantly to replace a faulty exciter on any one of the machines. The terminals of each of the three phases are brought out and the windings connected "Y" and this neutral assembled to connect with ground bus through a disconnect switch and oil circuit breaker. Current transformers are placed in each line between the machine and neutral and afford means of differential protection.

The circuit of the main generator bus is through sets of disconnect switches on both sides of line oil circuit breaker. Also a bypass switch is provided to short circuit the oil breaker in case it is desired to remove this from service while in operation. Through this system of switching equipment the machine is connected to the low-tension side of power transformer bank, consisting of three 14,000-kva., single-phase Westinghouse transformers connected delta on the 12,000-volt side and "Y" on the 110,000-volt side.

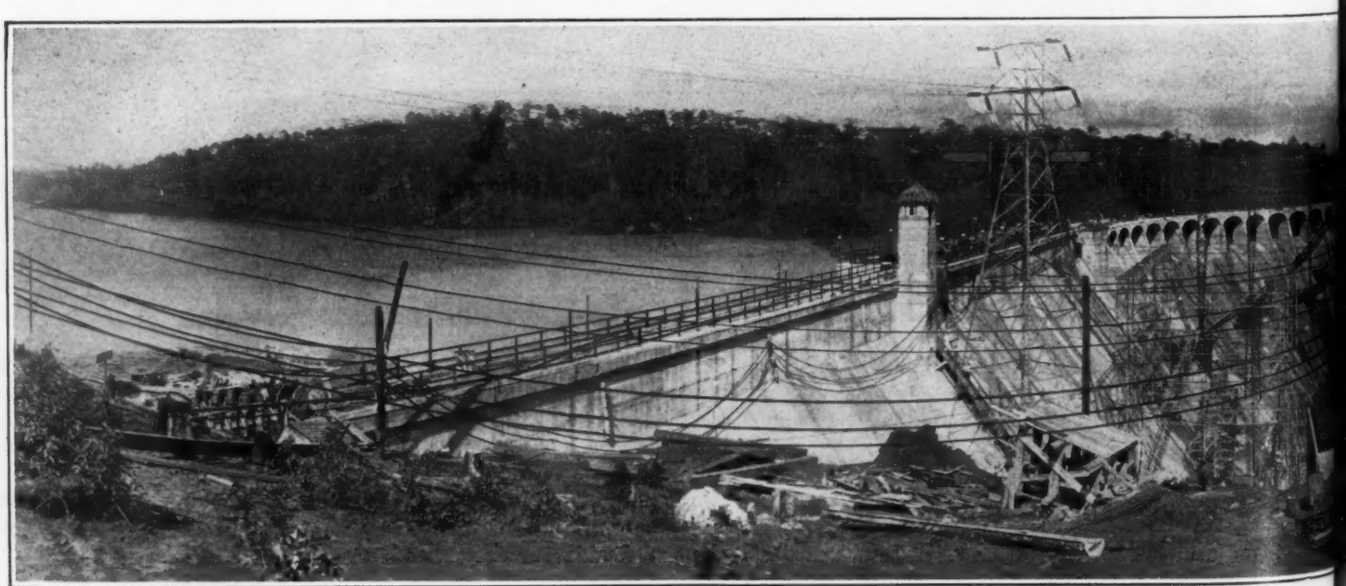
In regard to relay protection, each machine and its auxiliaries and equipment are protected by a differential relay connected to current transformers in the neutral side of machine and in the bus next to the low-tension side of the power transformer bank. Also a combination for similar protection is provided by current transformers connected in bus at machine terminals and again in the high-tension side of transformer bank. Any unbalancing of phase currents due to faults such as grounds, short circuits, open circuits, etc., will cause all equipment to be opened at once and the machine to be completely cleared from the line.

The engineering department of the Alabama Power Company in Birmingham made the studies, the general layout and the detail plans for all of the structures on this project. The design work was done under the supervision of O. G. Thurlow, chief engineer and vice-president of the Alabama Power Company, also J. A. Sirnit, designing engineer; F. E. Hale, assistant designing engineer, and R. R. Stone, in charge of electrical design. S. H. Woodard was consulting engineer. The construction work was carried on under the supervision and direct control of A. C. Polk, construction manager and vice-president of the Dixie Construction Company, the engineering and construction organization of the Alabama Power Company, and C. C. Davis, superintendent of construction at Cherokee Bluffs. The writer had charge of all field engineering and design.

MAJOR CONSTRUCTION FEATURES

Spillway Section.—Mass concrete with 0.85 to 1.00 slope on downstream side and vertical face on upstream side. Arched in plan, upstream face has radius of 530 ft. Maximum height from top of lowest apron (elevation, 340) to crest of spillway is 134 ft. and to top of gates 150 ft. Maximum height from lowest area of foundation to crest of dam 151.5 ft. Width at the base 160 ft. Spillway gates 32 ft. 2⅛ in. wide and 16 ft. high. Spillway deck or gate operating bridge (elevation, 500) 24 ft. 10⅛ in. wide. Total length of spillway section 744 ft. For operating the spillway gates, a 40-ton traveling crane has been installed.

Secondary or Auxiliary Dam.—Constructed downstream from toe of main dam, forming pool or cushion of water 22.5 ft. deep to receive overflow over spillway sections No. 1 to No. 12 inclusive. Its purpose is to prevent erosion of the rock foundation beneath the spillway section toe, and immediately downstream from it. The auxiliary dam is arched,



SWEEPING VIEW OF MARTIN DAM AS IT APPEARS

having an inside radius of 117.71 ft. Dimensions: Top width, 10 ft.; minimum width at base, 39 ft.; height above paving, 22.5 ft.; length between transition sections, 216.5 ft., and total length, including transition sections, 367.7 ft. The entire area of rock between the auxiliary and main dams has been covered with a concrete paving with minimum thickness of 12 in.

Headwork Section.—This section, constructed between the spillway and retaining section, contains steel penstocks, trash racks, head gates, stop logs and gate-operating mechanism. The substructure is of mass concrete, while structure above bottom of penstock floor is reinforced concrete.

Headworks section for each generator unit contains three inlets 24.6 ft. high and 9 ft. wide, converging to common 20-ft. diameter concrete penstock, which joins a 20-ft. steel penstock surounded by concrete. This steel penstock joins, in an inspection chamber, the steel scroll case. Each penstock opening is provided with a vertical sliding steel gate, gates being provided with "latching and releasing devices." When raised or in open position, each gate is suspended by means of a heavy chain, which is engaged in the arm of the "latching and releasing device." When this device is operated, the chain is disengaged, permitting the gate to drop. Its velocity is held to a maximum of 60 ft. per minute by two hydraulic cylinders, the pistons of these cylinders being attached directly to the gates.

Steel stop logs of the sliding type are provided to close one entire unit of the headworks, to be used if a penstock gate becomes inoperative. On the deck of the headworks a 50-ton capacity electrically driven gantry crane has been installed, which travels the entire length of headworks deck.

Earth Dike on East Shore.—A concrete corewall founded on hard schist and carried below any pervious seams was constructed on a line with spillway pier No. 21 and east of upstream face of dam. This dike was necessary to fill a depression in a ridge on the east shore. The dike has the following dimensions: Top width, 40 ft.; maximum base width, 261 ft.; average width, 130 ft.; total length, 523 ft.; upstream slope of 1 to 3 and downstream slope of 1 to 2.

Joining the west end of the corewall and extending upstream at an angle of 65 deg. with corewall a concrete wing wall has been built, to serve as a wave barrier for the dike and to prevent erosion on the east shore from water passing over the spillway crest between piers No. 18 and No. 21.

On a line with pier No. 21 and extending downstream a concrete wall has been constructed to hold the high face of the excavation for the spillway on the east shore, and also to prevent erosion of that face and to confine the overflow water from bay No. 20. This wall has a maximum height of 81 ft., minimum height of 14 ft., maximum thickness of 23.2 ft., with top width tapering from 8 ft. to 4 ft.

Power House Building.—Dimensions: Length, 250 ft. east and west; width, 59 ft. in generating unit section, and 98 ft. in the annex; height, 74 ft. from generator floor to eaves and 99 ft. to peak. The substructure is built of reinforced concrete. The superstructure, which begins at the generator room floor level, has reinforced concrete walls for height of 14.5 ft. Above this point the building is constructed of structural steel frame and brick.

Turbines.—There are three 45,000-hp. turbines of vertical type with Francis inflow runner with runner and generator suspended on main shaft supported at the top by a spring thrust bearing. Two turbines were furnished by Allis-Chalmers Manufacturing Company and one by William Cramp & Sons, the latter being an I. P. Morris Company design. The maximum operating head is 150 ft. and the normal head 129 ft.

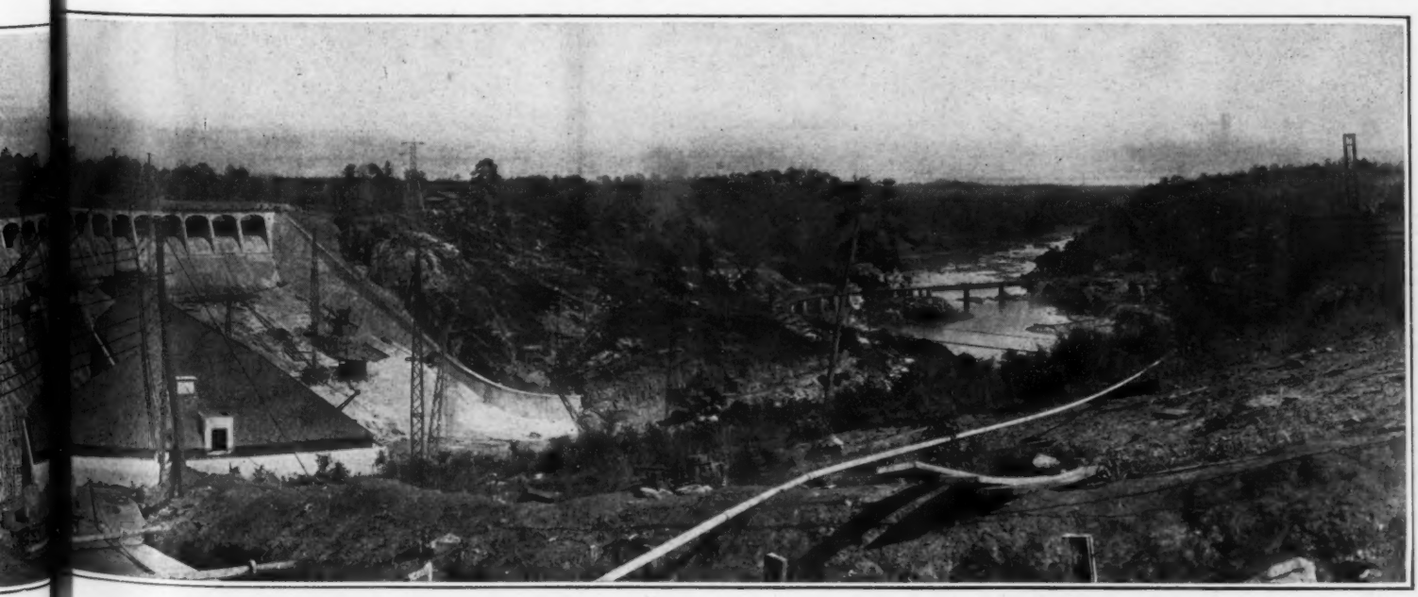
Outdoor Substation.—This is located on the west shore hill. It is 654 ft. long and 80 ft. wide, covering 1.2 acres. Just west of the substation a brick carrier current house has been constructed. Twenty-eight galvanized steel towers 94 ft. high and fourteen galvanized steel towers 55 ft. high form the supporting structure for the disconnect switches, strain insulators, etc. Ten 14,000-kva. and three 1,000-kva. transformers and the oil switches are located on the transformer deck of the headworks. One transformer is provided as a spare.

Method and Organization for Clearing Reservoir Basin.—Field operations necessary for preparing the basin for flooding were divided into three major divisions. They consisted of purchasing of lands, handled by the land department; clearing of basin, handled by the construction department, and sanitary and malarial control, handled by the medical department.

Approximately 33,800 acres was cleared, on which it was estimated there was 18,000,000 ft. of merchantable timber. More than 80 per cent of the timber suitable for lumber was utilized at the dam or disposed of through commercial channels. All timber and brush within the draw-down area, between 430 and 490 contours, was removed or burned. All brush and timber below the maximum draw-down that would project above this elevation was either removed or cut and wired down to prevent floating. The clearing was handled by contractors and company forces. A total of 64 contracts were let.

Local farm labor was employed as far as practicable on the clearing, the company co-operating with farmers to the extent of employing labor between crop seasons and releasing them to plant and gather crops. This proved to be very satisfactory and this class of labor was the most efficient used. During the farming seasons and the time when the organization was at its peak labor was recruited from other sources.

One of the first steps taken by the sanitary unit was to make a malarial survey of the area to be flooded and for a

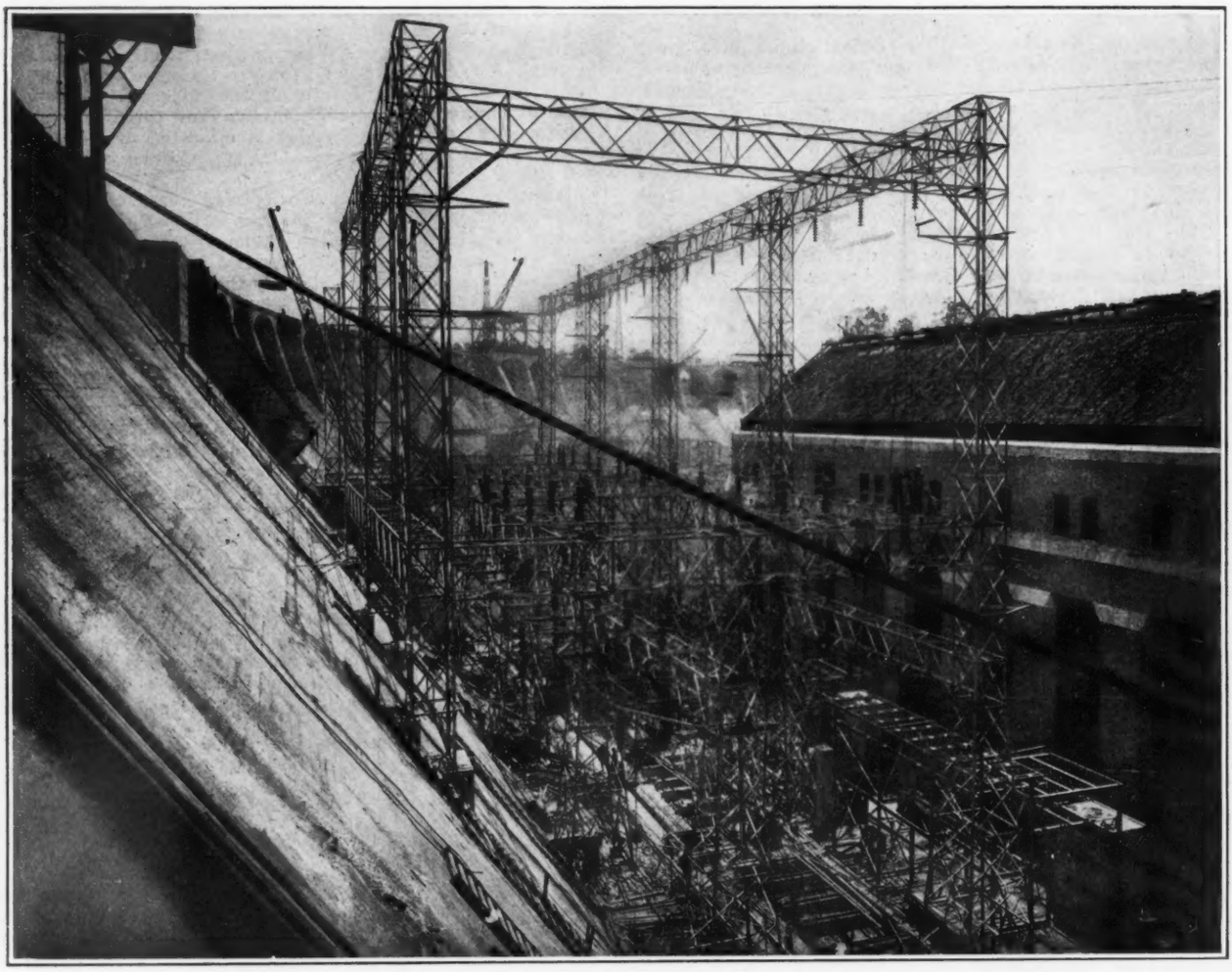


FROM THE WEST BANK OF THE TALLAPOOSA RIVER

radius of about a mile adjacent thereto. Hatcheries were established throughout the basin for the purpose of breeding Gambusia, or "top minnows." As the water rose these were released and destroyed wigglers of the malaria-bearing mosquito with which they came in contact.

Very definite sanitary regulations were established and put in force at all camps. Cook and mess tents were thoroughly screened. All drinking water was inspected and tested. Every care was taken to prevent fly and mosquito breeding around the camps, and disinfectants were constantly used.

As the water was raised in the lake a force of about 50 men was employed to spray the water with oil to prevent mosquito breeding. The equipment consisted of ten small boats equipped with air and oil tanks, spraying equipment and outboard motors; one large launch with a large oil and air tank; one small barge with air compressor and oil tanks for servicing the small boats; and several oil tanks of 1,000-gal. capacity, which were placed at convenient places on the edge of the lake to supply oil to the spraying fleet. About 40,000 gal. of oil was used, the entire area being covered once every ten days. The oil used was 75 per cent kerosene and 25 per cent crude oil. The oiling method has been found to be the most effective means of preventing mosquito breeding. The spraying process begins with the mosquito-breeding season, which is early summer, and extends to frost. This will be carried forward each season.



ARRANGEMENT OF TRANSFORMER DECK BETWEEN POWER HOUSE AND DAM

DETAIL CONSTRUCTION DATA

Diamond Drilling. — Several years before construction operations were started eleven diamond drill holes were sunk in the area of the dam site. It was later decided to sink eleven additional diamond drill test holes in the east bank of the river to determine more closely the stratification and nature of the rock, etc., for the corewall of the dike and for the east abutment foundations. The results from these cores gave a satisfactory prediction for the rock foundations for these sections. When cofferdam No. 3 area was dewatered, it was considered advisable to sink six additional diamond drill holes in the rock foundation for the spillway between piers No. 4 and No. 13. The results of the latter holes controlled the excavation depth for the spillway in that section.

Preliminary Construction.—Construction of the camp was started in July, 1923. The main line standard-gage railroad, six miles long and connecting the project with the Birmingham & South Eastern Railroad at Asbury, Ala., was started in June, 1923, and completed in January, 1924. The first cofferdam was started in July, 1923, and was finished on Feb. 28, 1924, but pumping out was started on Nov. 13, 1923, prior to completion.

The yard and plant tracks were divided into three divisions—east shore, west shore and high line. Connecting the east and west shore divisions at the up-stream end of the yard another bridge was constructed carrying the double-track standard-gage system. This bridge, 600 ft. long and consisting of steel girders resting on concrete piers, formed the main feeder for concrete cars to derricks and the main outlet for rock-loaded cars from the excavation. A branch line was constructed from this bridge on the single-track trestle passing through the location of the proposed bus vault in the power house. In addition, a branch line was constructed on a trestle founded on timber bents in the tail race and extending through unit No. 1 power house. The main line river bridge formed a connecting link between the east and west shore divisions at the down-stream end of the west shore division. Downstream from the main line river bridge the east shore lines were

extended for approximately 3,700 ft. and a ladder track system was built to secure access to the permanent equipment storage yard and car repair shop, etc. At the extreme downstream limits on the east shore division the planer mill was first located. In addition, the reinforcing steel yard, the ice storage house, etc., were also located in that vicinity.

The high line railroad was built expressly for handling concrete materials from the main line railroad to the sand and gravel storage bins and the cement warehouse. This division was 4,430 ft. long and joined the main line railroad at approximately 3,986 ft. from the lower river bridge at the project.

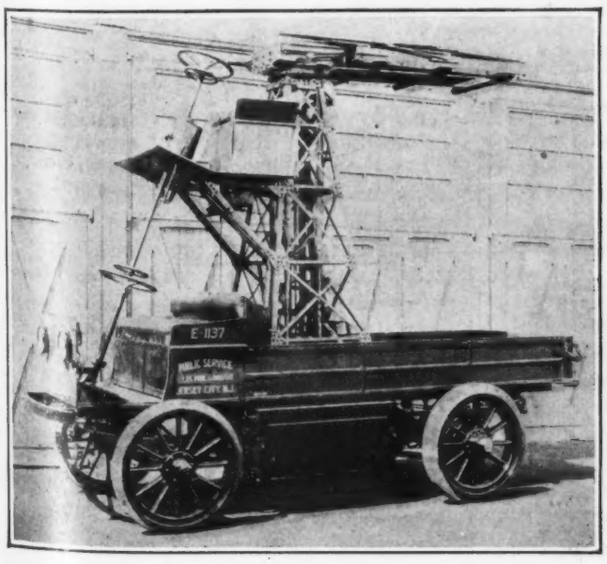
Cofferdams.—The cofferdam layout was divided into three sections built in sequence. No. 1 cofferdam formed a barrier across the channel of the river and inclosed the power house, headworks and spillway from the east face of the headworks to pier No. 4. Very little trouble was experienced in dewatering and maintaining dry condition. Round logs were used and drifted together with 1x20-in. steel dowels in all coffers. Coffer No. 2 joined downstream arm of coffer No. 1 and included tail race and extremities of draft tubes. Construction was started on Nov. 8, 1923, and was finished in October, 1924. Cofferdam No. 3 crossed the shallow section of river. It was constructed after unit No. 4 headworks and spillway stream control openings No. 1 and No. 2 had been concreted to a sufficient height to carry the summer flow of the river. Construction started on March 21, 1925, and was finished on April 23, 1925.

Stream Control.—Stream control was provided for by six openings: one in unit No. 4 headworks, having a clear span of 27 ft. and five in the spillway section, each having a clear span of 30 ft. at the upstream end. The 20-ft. penstock in unit No. 4 serves as a stream control opening during the actual operation of the plant. After the initial concrete in these openings was poured the rest was poured in 10-ft. stages, alternating in elevation heights. Three closure caissons were built to serve both as water barriers and forms for the upstream face. The closing of the control openings was started on April 29, 1925, and was completed on July 8, 1925, a total of 71 days. Concrete was poured on 87 shifts, 43 day shifts and 44 night shifts. All flow of the river past the dam ceased on June 9.

Concreting. — Derricks handled concrete buckets from cars. Panel forms gave satisfactory service in spillway, retaining section, corewall, portions of headworks and other sections. Special and more complex forms were required for the draft tubes, wheel pits, headworks and spillway deck.

Splendid results were experienced with the spillway deck forms with a maximum clear span of 30 ft. Absolutely no deflection occurred in the finished concrete deck. Various proportions were used in different sections of the structure. After 50,000 cu.yd. of concrete was poured the Abrams method of pouring concrete was introduced and followed throughout the remainder of work. After the concrete-mixing crews had become trained to this system of proportioning no trouble was experienced. Undoubtedly more satisfactory results were obtained, both from economical and strength standpoints, by this method.

A rather bold departure from ordinary methods was made in the use of cobbles or 6-in. to 8-in. diameter stone. Concrete buckets were first filled with mixed concrete to a height that would allow placing 1 yd. of cobbles over the mixed concrete. After the admixture of cobblestone and mixed concrete the whole was dumped into forms, cobblestones being carefully spread by hand labor, using shovels. About 32,000 cu.yd. of cobblestones was used, this being 8.1 per cent of the total concrete placed and representing an important saving in concrete. Large plumstone was also used in mass concrete sections of the project, being employed chiefly as bond stone between adjacent pourings of concrete. For the entire Martin Dam project there was poured a total of 440,000 cu.yd. of concrete.

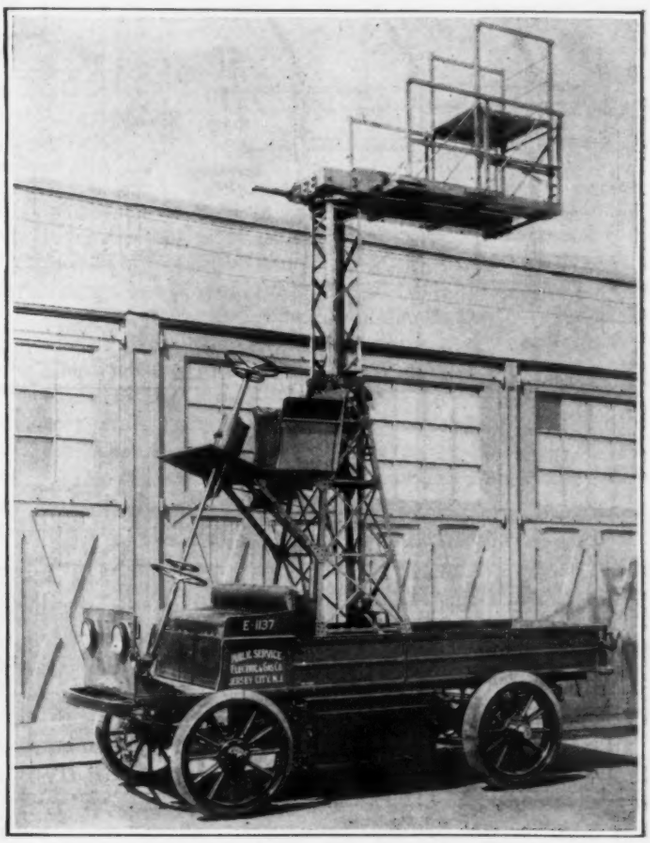


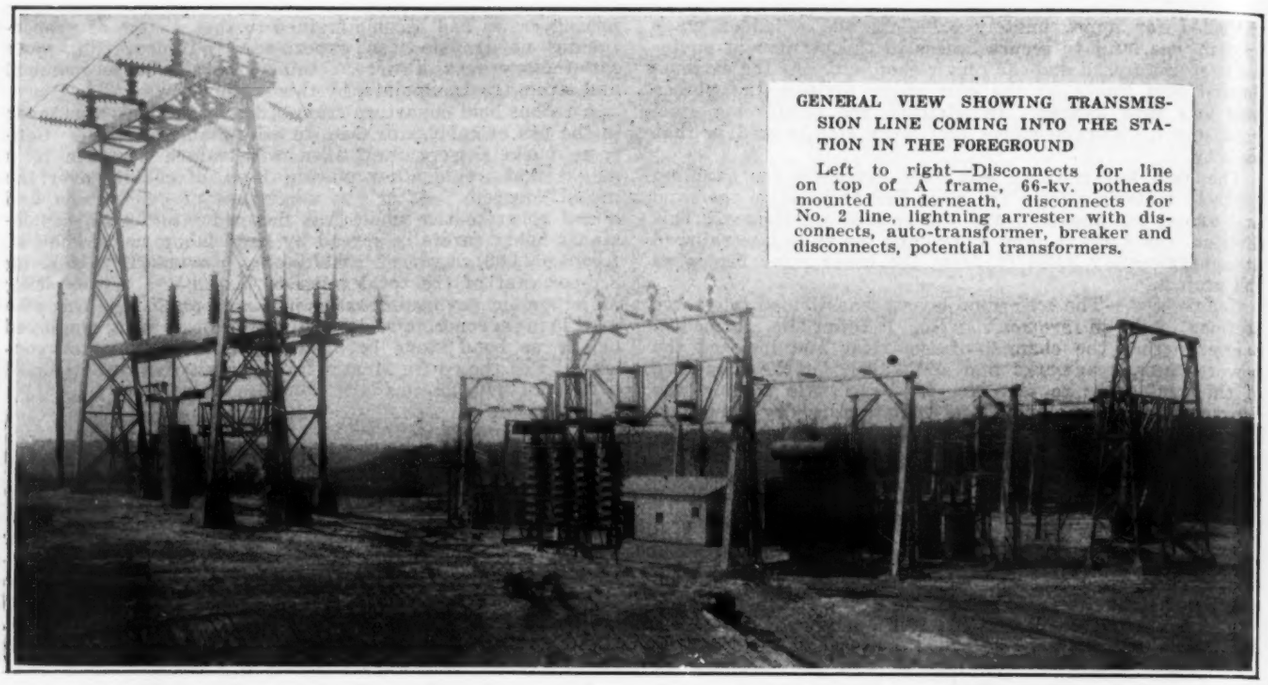
Electric Tower Wagon Designed for One-Man Operation

A DUAL-CONTROL electric tower wagon designed for one-man operation is the latest addition to the automobile fleet of the electric distribution department of the Public Service Electric & Gas Company. So far the one pictured below is the only one in the company's service. It is being used in Jersey City and if its try-out is satisfactory others will be purchased.

This tower wagon, which was built by the Commercial Truck Company for use in the maintenance of street lighting, has two stationary driving positions, the upper one being about 5 ft. above the regular position and about a foot below the working platform. When the workman is finished at one pole he has only to step down a short distance to the upper driving seat to drive the wagon to the next pole. This arrangement obviates the necessity of having one man to drive the wagon from pole to pole and another to do the work.

The tower is one of the telescoping type and can be raised to a maximum height of 17 ft. 8 in. Its normal height is 11 ft. 5 in.

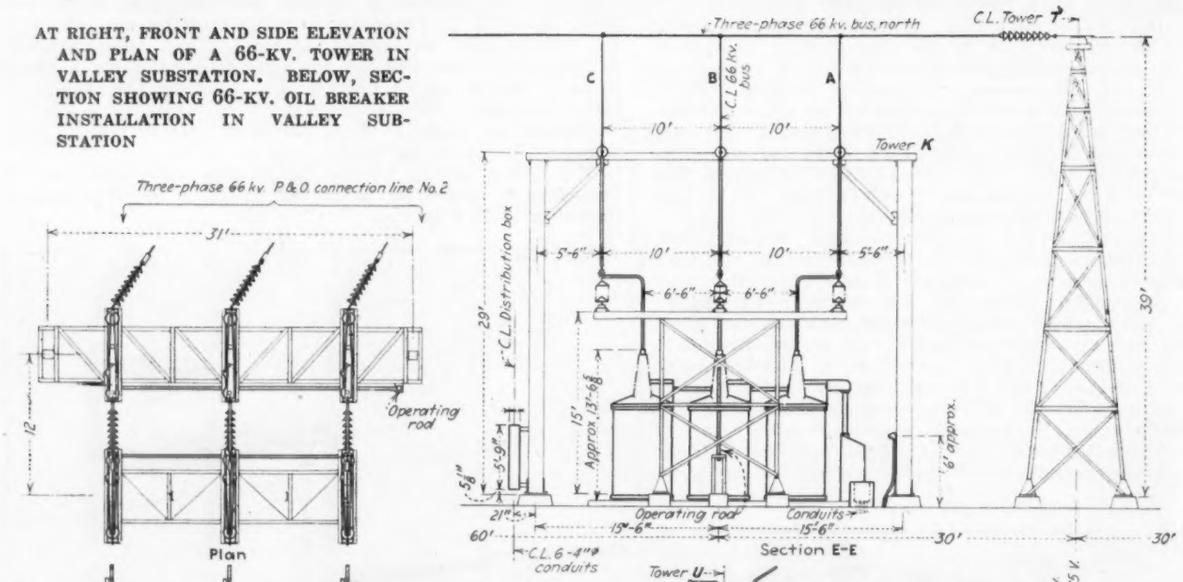


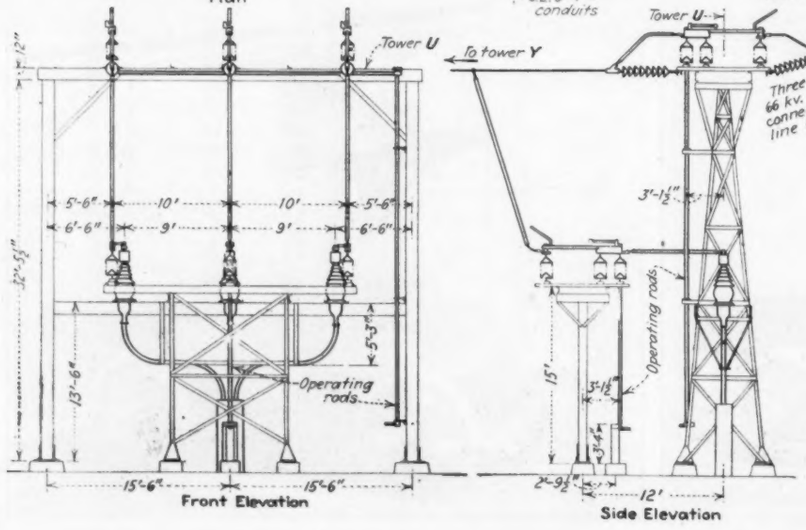


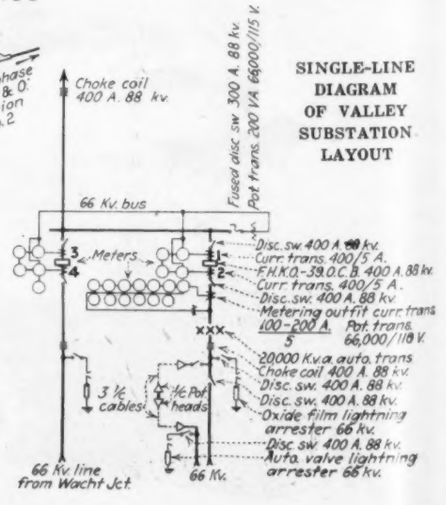
GENERAL VIEW SHOWING TRANSMISSION LINE COMING INTO THE STATION IN THE FOREGROUND

Left to right—Disconnects for line on top of A frame, 66-kv. potheads mounted underneath, disconnects for No. 2 line, lightning arrester with disconnects, auto-transformer, breaker and disconnects, potential transformers.

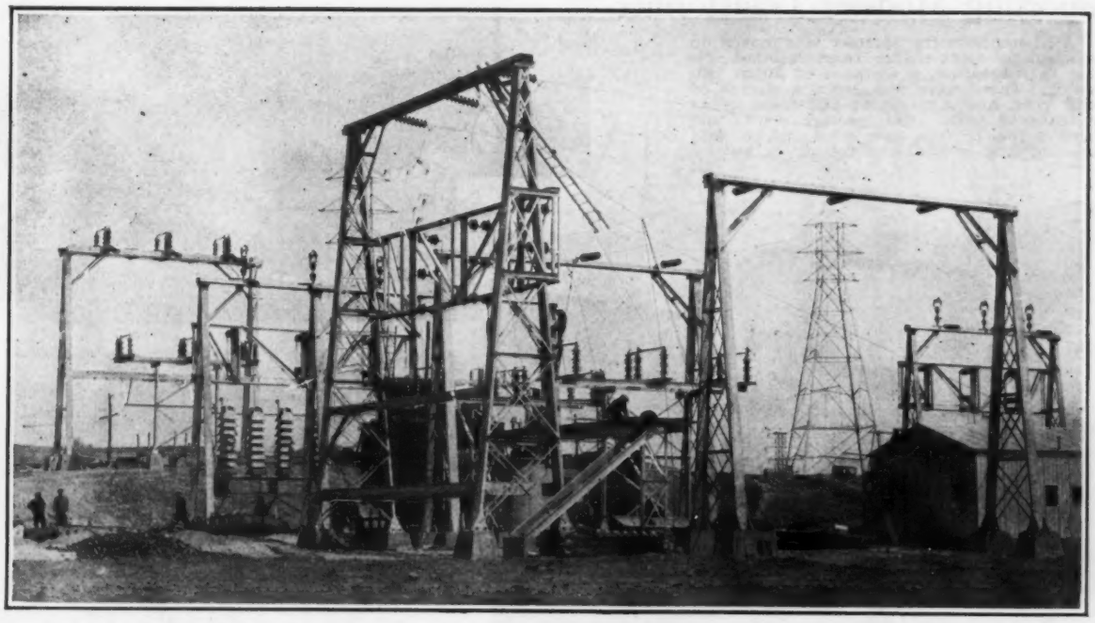
AT RIGHT, FRONT AND SIDE ELEVATION AND PLAN OF A 66-KV. TOWER IN VALLEY SUBSTATION. BELOW, SECTION SHOWING 66-KV. OIL BREAKER INSTALLATION IN VALLEY SUBSTATION






Choke coil 400 A. 88 kv.
Fused disc. sw. 300 A. 88 kv.
Pot. trans. 200 VA 66000/115 V.
66 Kv. bus
Meters
Disc. sw. 400 A. 88 kv.
Curr. trans. 400/5 A.
F.H.K.O.-39.O.C.B. 400 A. 88 kv.
Curr. trans. 400/5 A.
Disc. sw. 400 A. 88 kv.
Metering outfit curr. trans. 100-200 A. / 5
Pot. trans. 66,000/118 V.
20000 Kv.a. auto. trans.
Choke coil 400 A. 88 kv.
Disc. sw. 400 A. 88 kv.
Disc. sw. 400 A. 88 kv.
Oxide film lightning arrester 66 kv.
Disc. sw. 400 A. 88 kv.
Auto. valve lightning arrester 66 kv.
3 ½ cables
½c. Pot. heads
66 Kv. line from Wacht Jct.
66 Kv.

SINGLE-LINE DIAGRAM OF VALLEY SUBSTATION LAYOUT



STEEL WORK IS COMPLETE AND MEN ARE PUTTING UP STRAIN BUS. A LADDER LASHED TO A FRAME ALLOWED A MAN TO REACH THE STRAIN CLAMP AND TIGHTEN IT UP

An Interconnection Substation

Construction Features and Details of Station at One End of a 66-Kv. Tie Line Between Penn-Ohio Electric Company and Duquesne Light Company —Handling of Equipment and Costs of Substation Elements

By M. R. SUMNER
Construction Engineer Duquesne Light Company
Pittsburgh, Pa.

SEVERAL types of substations are required on a large electrical system to satisfy operating needs. High-tension substations at generating stations and at interconnecting points with other systems embody elements of design and operation different from those proper for distribution substations of the various kinds. These high-tension stations must be very reliable and should have a permanency that will warrant the investment necessary to their installation. If they are used as interconnection stations between two systems, they must be designed to prevent disturbances on one system affecting service on the other and in addition provision must usually be made for metering energy at high voltage.

In addition to service requirements fixing design principles there are other elements that enter into substation construction practice. The time allowed for completion of the station, the season of the year at which the station is built, the construction equipment and personnel available for the work and many other special conditions affect the details of the design and the construction. Although the use of a minimum number of standard substations is the goal to be sought, it is often necessary to modify the design and construction features the better to satisfy conditions encountered for a particular installation.

On June 28 of this year a fifteen-mile steel tower 66,000-volt tie line was completed between the systems of the Duquesne Light Company and the Penn-Ohio Electric Company. This line was a joint project of the two utilities to provide insurance for each property and to permit each system to take advantage of the economies made possible by diversity.

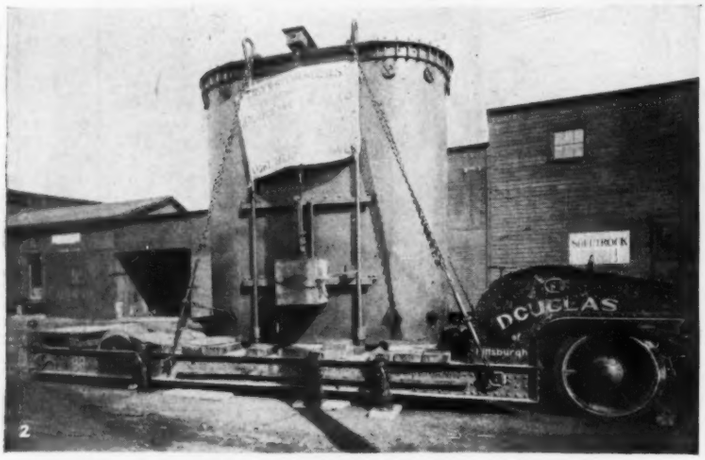
The tie was made at one end of the line at the Valley

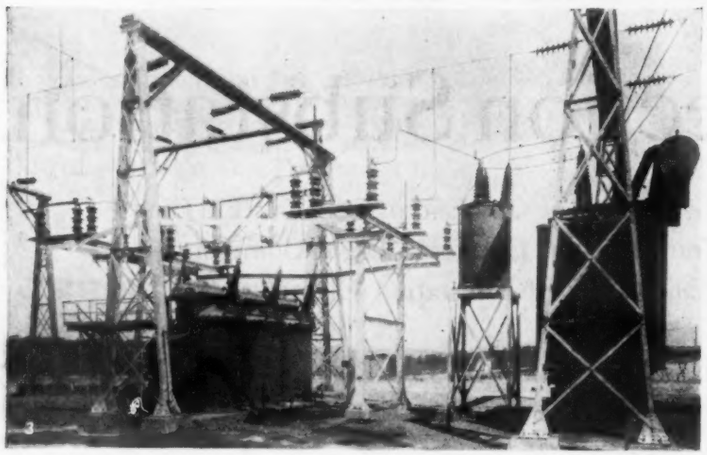
MAJOR EQUIPMENT AT VALLEY SUBSTATION

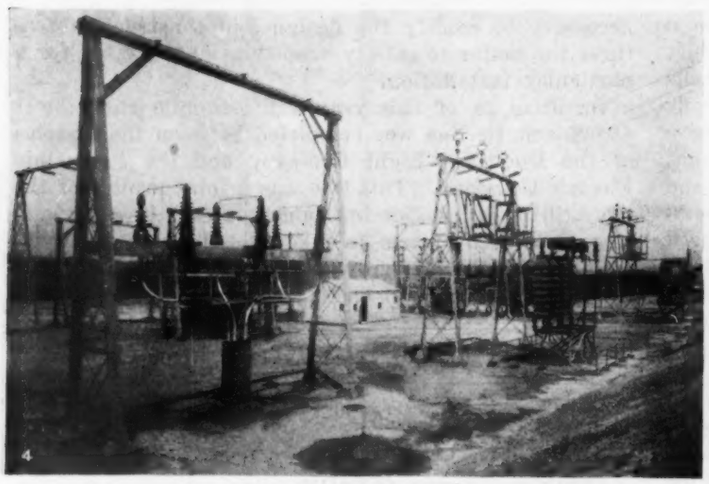
Nine 400-amp., 88-kv. gang-operated disconnect switches
Two 400-amp., 88-kv. oil circuit breakers
One 300-amp., 88-kv. fused disconnect switches
Three 200-kva., 66,000/115 potential transformers
One metering outfit—current transformer, 100/200/5-amp. potential transformer, 66,000/110 volts.
One 20,000-kva. auto-transformer, 66,100/72,600 volts.
One 66-kv. auto valve lightning arrester
Two 66-kva. oxide film lightning arresters
Twelve 72-kv. 1/c—oil-filled potheads
72-kv. 1/c—oil-filled cable
Necessary meters and relays
Battery and motor-generator set

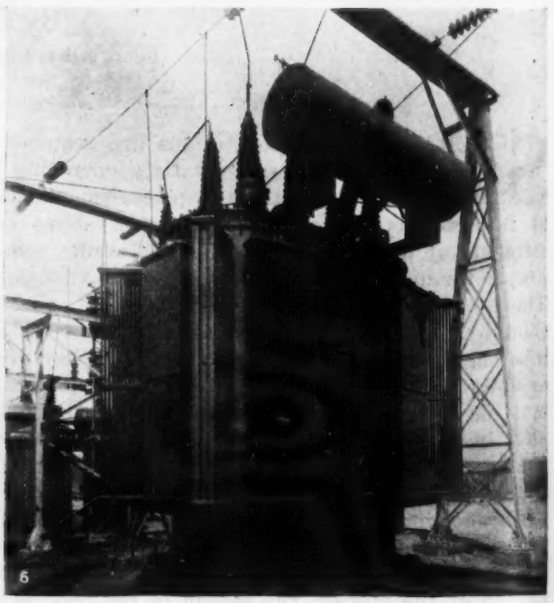
Transporting Monster Transformer

A 52-ton auto transformer was moved on a specially built trailer from railroad siding to substation, a distance of about two miles. There were five turns, a stretch of new road and a slight up-and-down grade to contend with. This picture shows one turn made on the new road, which was built of slag, graded and rolled.

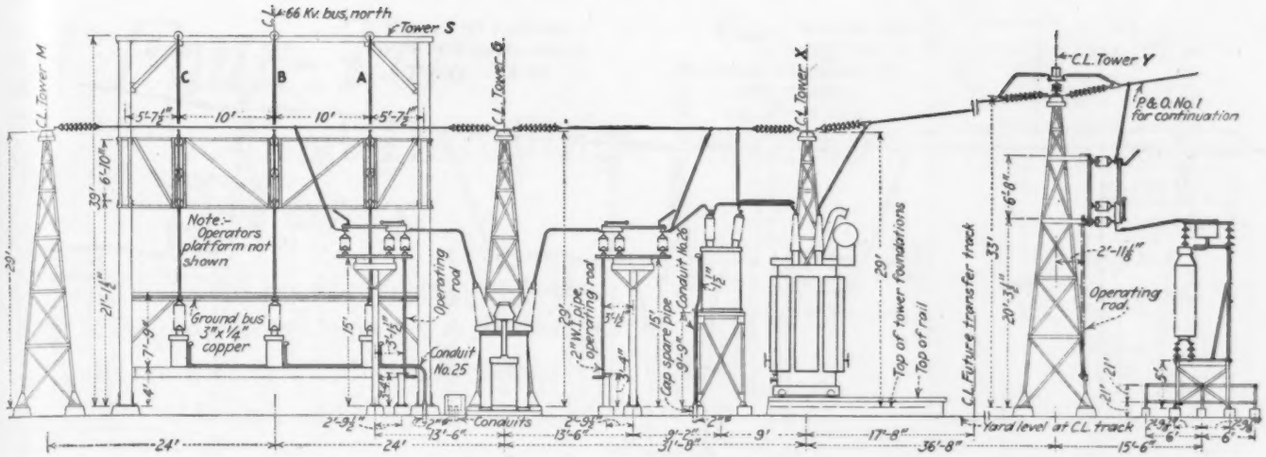








1. The slight up-grade on improved road. Three trucks were doing the hauling and two were placed in the rear to brake on down-grades.
2. The transformer placed on trailer ready to go.
3. This picture shows method of mounting and tieing together auto-transformer, metering transformer disconnects and breaker. Copper tubing was used for jumpers between the equipment.
4. General view, showing in the foreground two sets of 66-kv. potheads mounted on an A frame. The ultimate plan has another 66-kv. line terminating on this frame above the potheads.
5. Three single-phase potential transformers mounted in base of A frame and tapped to line through fused disconnects.
6. The auto-transformer in place, showing the tap changing wheel in front.



SECTION THROUGH PART OF VALLEY SUBSTATION, SHOWING 66-KV. EQUIPMENT

substation of the Duquesne Light Company. An auto-transformer installed at this point is to compensate for line losses and otherwise to facilitate control when the two systems are tied together. A bus tie breaker and one tie line oil breaker are used, but the plan is to build ultimately a larger interconnection and distribution substation that will cost in excess of $1,000,000.

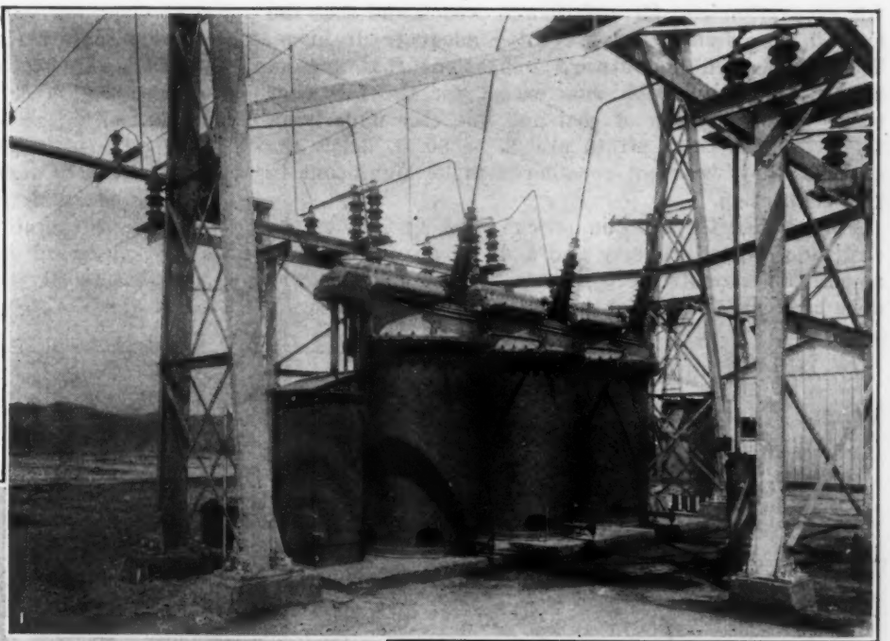
Construction Methods.—The grading, foundations and steel work for the station were started in the fall, but an unusually severe winter prevented the completion of the foundations and grading until this spring. The steel was erected in six weeks—April 1 to May 15. The installation of electrical equipment was made in five weeks—May 1 to June 5. The engineers of the Duquesne Light Company laid out a progress chart against which the work was checked weekly. If any of the work

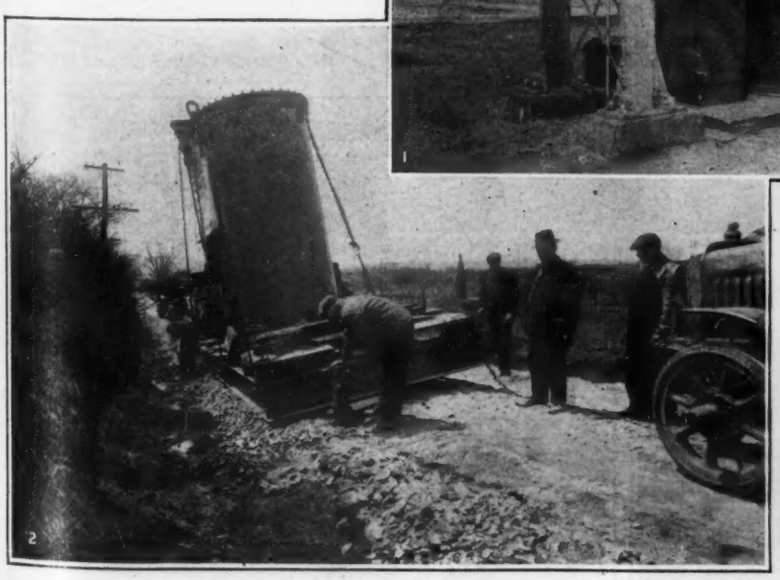
APPROXIMATE COST OF VALLEY SUBSTATION

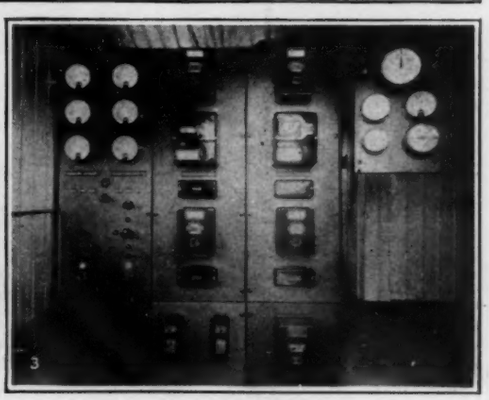
Building and structures (erected)	$30,660
Electric equipment	82,900
Labor and drayage	31,115
Excavation and fill	30,400
Road improvements	11,000
Miscellaneous	35,525
Total	$221,600

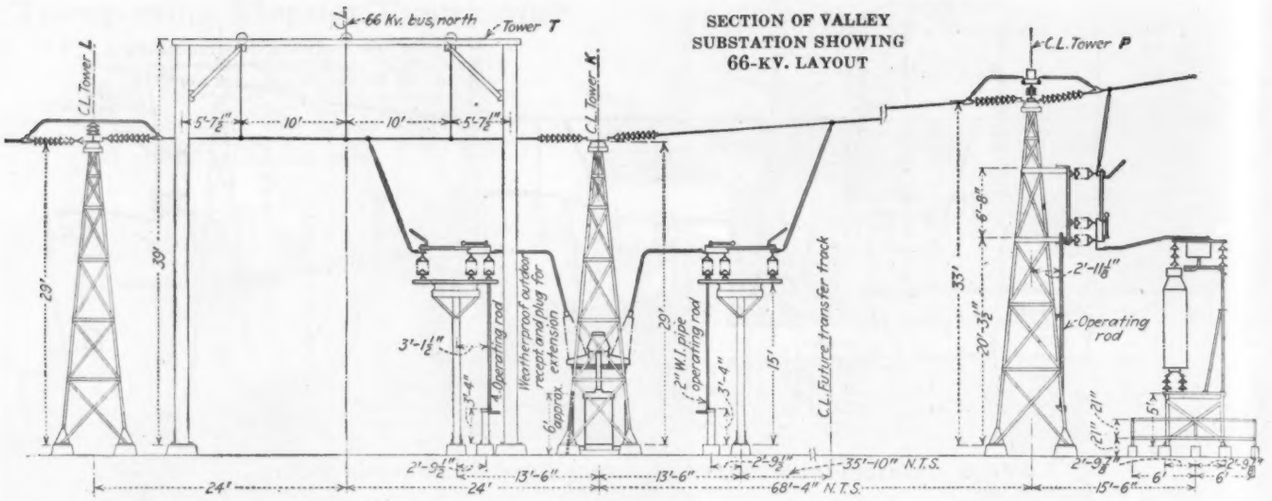
Valley Substation Views

1. A close-up showing the type of 66-kv. breaker used with the operating house on the right.
2. A section of the new road gave away, allowing the auto transformer to get quite a list to one side, but jacks and man power soon had it righted again and on the straight and narrow path to its destination.
3. Control and meter boards.









lagged behind the necessary steps were taken to catch up again.

The unique feature on this job was the ground water encountered. The station is located on a relatively level plateau. The west side drops off abruptly toward the Beaver River, and on the east side there is a gentle rise to a crest possibly a mile away. Because of this slope of the substation site about $30,400 was expended for excavation and fill and then it was found that the subsoil was a clay that prevented adequate drainage. There had been no outward indications that ground water would be troublesome except for the fact that there was a stratum of coal and fine clay underlying the area. As these strata are 70 or 80 ft. below the surface, they were not considered to be significant in this connection.

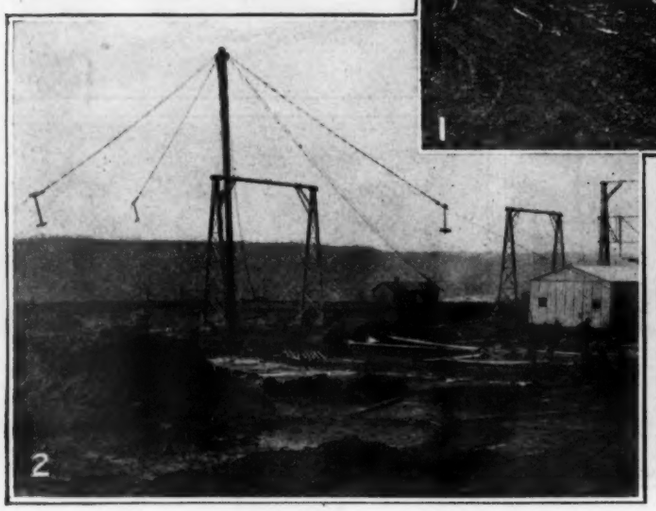
Plans called for a maximum cut of about 8 ft. on the east side of the property and a fill of about the same amount on the extreme west side. The excavation was done by steam shovel and the material was hauled to the "fill" area by teams, as the water encountered made trucks impracticable.

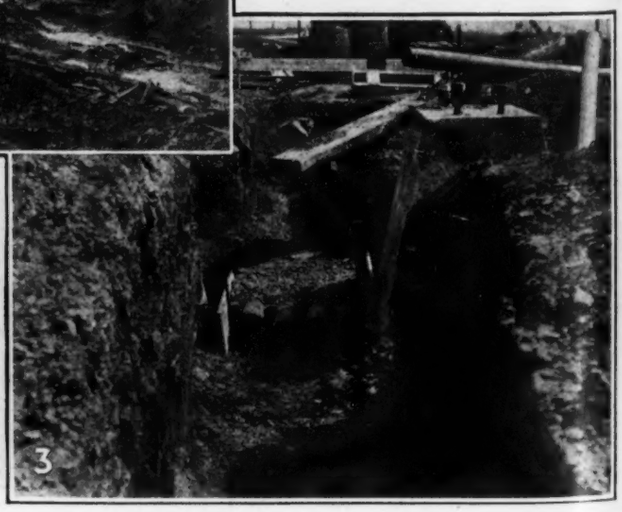
The water assumed such proportions that temporary, and later permanent, drains over the entire area had to be provided. The permanent drains are farm tile laid in ditches about 20 ft. apart filled with coarse gravel and carry the surface water over the hill away from the location.

Accompanying tables and illustrations give detail information on the substation and the construction methods used. The complete job required about 90 tons of galvanized steel and approximately 1,200 yd. of concrete.

Company Organization.—The jobs described herein were constructed under the supervision of M. R. Scharff, chief engineer; M. R. Sumner, construction engineer; R. H. Long, general construction superintendent; E. A. Murray, electrical superintendent; R. B. Brissenden, general electrical foreman, and A. K. Walton, H. A. Randall and J. L. Graffius, electrical field engineers.

Where Water Was Found in Abundance on the Top of a Hill





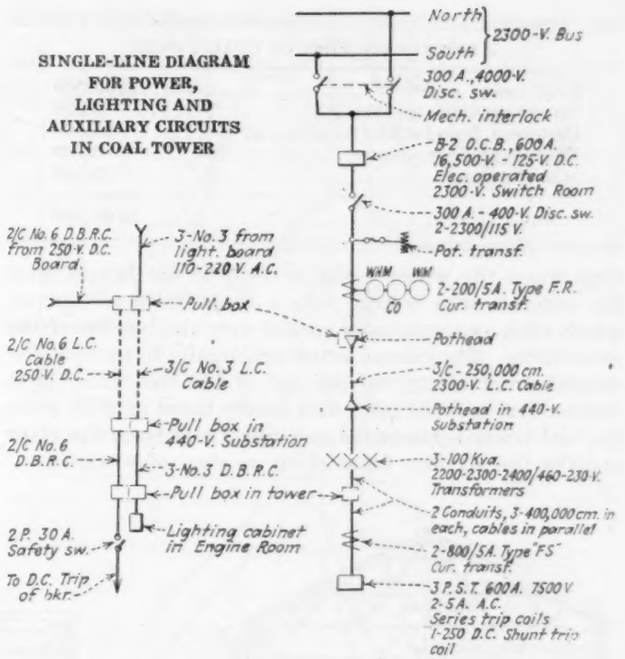
1. Excavation. Steam shovels, horses, mules and tractors were used. The steam shovel came in very handy to pull the mules out of the mud when they went in.
2. Steel work just started. Picture shows the condition of the ground before the drain pipes were installed.
3. The duct line consists of four 4½-in. fiber ducts laid in concrete.

A Four-Ton Coal-Handling Tower

Capacity 400 Tons per Hour—Hopper Capacity 125 Tons—Belt Conveyor to Bunkers—Barge Shifter Used—Construction Details and Costs

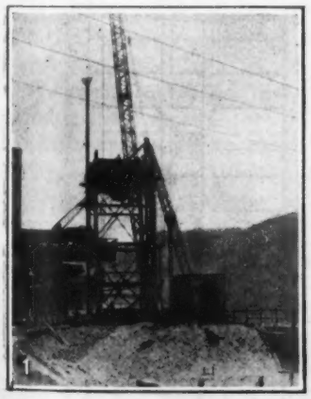
By M. R. SUMNER
Construction Engineer Duquesne Light Company
Pittsburgh, Pa.

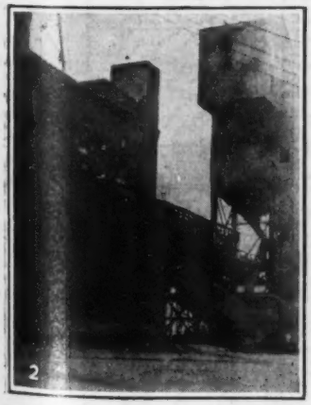
SINGLE-LINE DIAGRAM FOR POWER, LIGHTING AND AUXILIARY CIRCUITS IN COAL TOWER

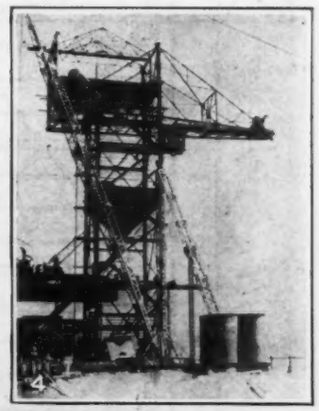

North
South
2300-V. Bus
300 A., 4000-V. Disc. sw.
Mech. interlock
B-2 O.C.B., 600 A. 16,500-V. - 125-V. D.C. Elec. operated
2300-V. Switch Room
300 A. - 400-V. Disc. sw.
2-2300/115 V.
Pot. transf.
WHM
WHM
CO
2-200/5 A. Type F.R. Cur. transf.
Pothead
3/c - 250,000 cm. 2300-V. L.C. Cable
Pothead in 440-V. substation
3-100 Kva. 2200-2300-2400/460-230 V. Transformers
2 Conduits, 3-400,000 cm. in each, cables in parallel
2-800/5 A. Type "FS" Cur. transf.
3 P.S.T. 600 A. 7500 V. 2-5 A. A.C. Series trip coils 1-250 D.C. Shunt trip coil
2/C No. 6 D.B.R.C. from 250 V. D.C. Board
3-No. 3 from light. board 110-220 V. A.C.
Pull box
2/C No. 6 L.C. Cable 250 V. D.C.
3/C No. 3 L.C. Cable
Pull box in 440-V. Substation
2/C No. 6 D.B.R.C.
3-No. 3 D.B.R.C.
Pull box in tower
2 P. 30 A. Safety sw.
Lighting cabinet in Engine Room
To D.C. Trip of bkr.

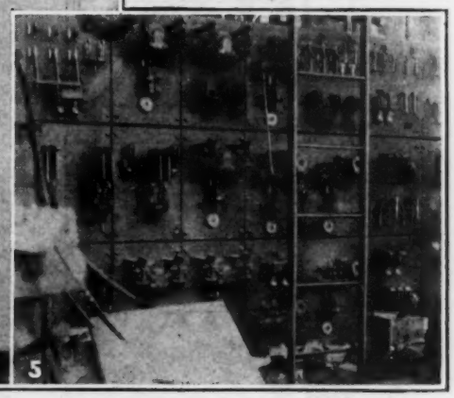
ANEW coal-handling tower at the Colfax station of the Duquesne Light Company was completed this year. This tower is at the station that is located on the Allegheny River and is for unloading coal from barges. It was started in January and completed in June of this year.

The foundations were partly under water, 185 yd. being poured in this way. Difficulty was experienced in pouring the footings and part of the foundations due to obstructions and water from the plant discharge tunnel, which is adjacent, and from the river. The area for the foundations could not be unwatered without serious delays and therefore the use of canvas for placing concrete under water and the placing of concrete-filled cement sacks to seal off the incoming water from the discharge tunnel was adopted. At a favorable









SKELETON AND COMPLETED VIEWS OF COAL-HANDLING TOWER, TOGETHER WITH GLIMPSE OF CONTROL PANELS OF SWITCHBOARD

1. Erection of tower with coal hopper in place.
2. Coal conveyor from tower to bunkers.
3. The completed tower with bucket being lowered. The conveyor is at lower left alongside of and below the railroad trestle. It delivers coal from the coal tower hopper spout to a hopper over the crushers in the plant coal handling system.
4. Tower at a stage where the superstructure is complete.
5. Control panels for tower motors.

APPROXIMATE COST OF COAL TOWER

Coal tower erected	$105,000
Barge-moving service	7,000
Concrete foundations	25,000
Electrical connections	9,700
Miscellaneous	13,300
Total	$160,000

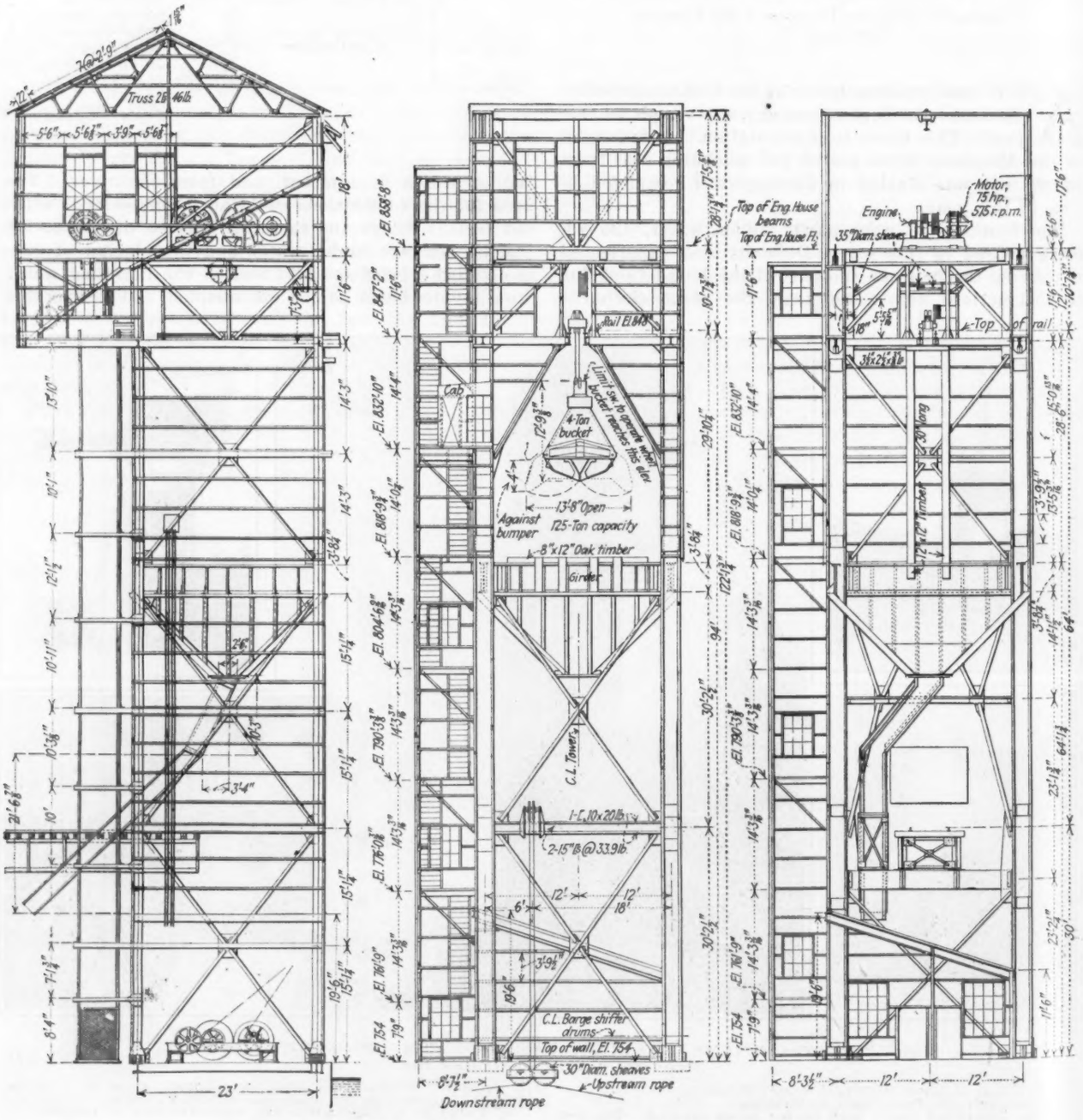
time when the water could be kept to the lowest level the concrete was poured into a large piece of canvas, which sank and gradually spread over the bottom of the excavation. The canvas acted principally to prevent the cement from being washed out of the concrete. It is now several months later and nearly three months since the coal tower commenced unloading coal from the river and the foundations have given no sign of weakness.

Another interesting feature of this project is the use of heavy, flat plates of copper-bearing steel instead of corrugated sheet for inclosing the tower, adding very much to the appearance as well as the permanency of the structure.

The belt conveyor to the bunkers can handle 300 tons per hour. A barge shifter was installed in connection with the tower that can handle barges 24 to 26 ft. wide and 100 to 175 ft. long at a speed of 125 ft. per minute.

ELECTRICAL EQUIPMENT

The electrical equipment for the tower operates at 440 volts, three-phase, 60 cycles. All motors are rated at 575 r.p.m. and are supplied by three 100-kva., 2,300/440-volt transformers. The motor equipment is as follows: Hoist, 250 hp.; rack, 75 hp.; conveyor, 30 hp.; barge shifter, 35 hp.



FRONT PORTAL AND SECTION OF REAR SIDE OF COAL-HANDLING TOWER

Electrical Construction Costs Stabilize

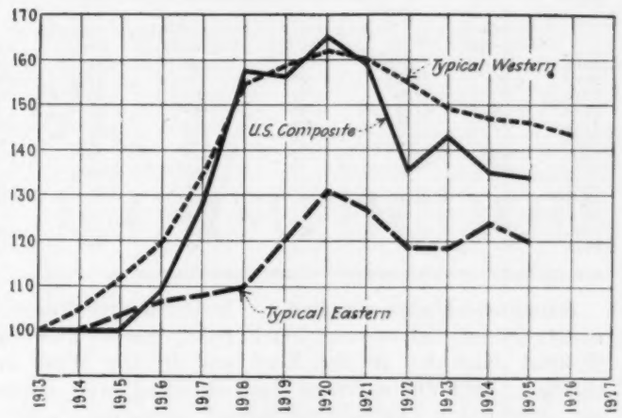
Apparent Straightening Out of the Labor, Supply and Equipment Cost Curves Facilitates Estimates of Future Trends—Averages Materially Below 1920 Peak but Above Pre-War Levels

HAS a period of relative stabilization arrived in electrical construction costs? Are there indications of a slackening in the upward trend of wages? How are changes in these trends related to variations in the physical values of utilities at the moment? These and similar unanswered questions provided the argument for the present analysis, the purpose of which is to determine the relative costs of major elements in new construction accounts as well as individual trends during the past fourteen years. Data presented herewith have been secured by the ELECTRICAL WORLD from representative companies throughout the United States and may be taken as reasonably comprehensive.

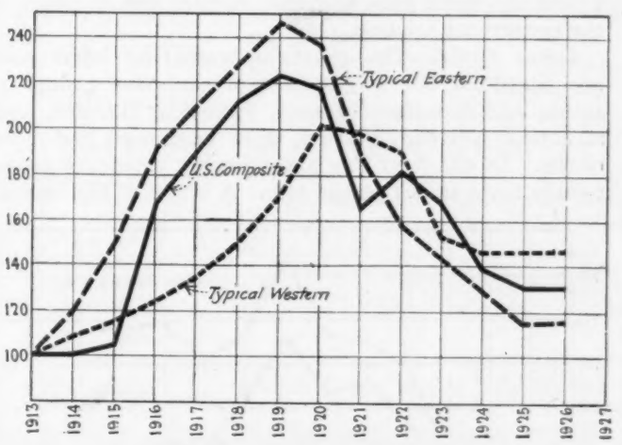
Prepared on an actual cost basis and thrown into index number form, both individually and by groups, the data presented make it possible to tell at a glance what are the major price trends of labor and of the material factors entering into the construction of a property.

Equipment.—Under the category of equipment are included both mechanical and electrical products entering into the total cost of generating stations and substations. Such items are included as steam power stations, hydro stations and steam turbo-generators, all on a per rated kilowatt basis; underground cable and copper line cable; power and distribution transformers; steel towers; switches; meters, etc. Certain of these, taken as representative, were studied more exhaustively, and composite series and curves built. Distribution transformer costs, for example, are presented in composite for the entire United States, and representative individual trends are shown for the East and West respectively. The composite line is made up of stated costs of typical companies in all sections of the country and is therefore fairly representative of conditions in all sections.

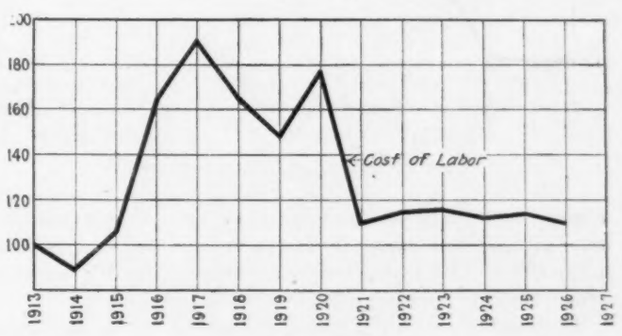
Underground cable and copper line cable are dealt with similarly. Both show the dominant influence of copper price fluctuations. Both display the same tendency to straighten out that is characteristic of most of the curves shown.



COST OF DISTRIBUTION TRANSFORMERS



COST OF UNDERGROUND CABLE



COPPER LINE CABLE COSTS

CONDENSED SUMMARY OF COST INDEX NUMBERS

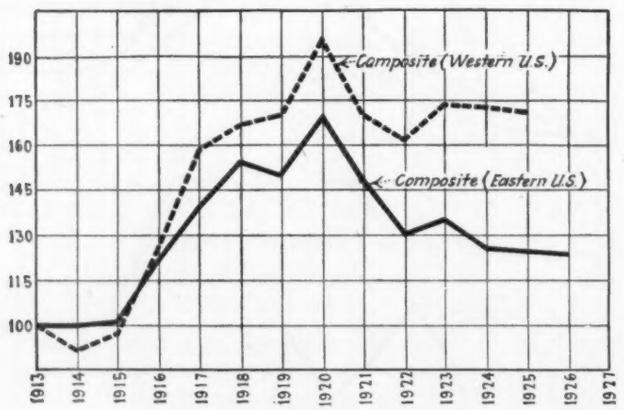
1913=100

	Wages		Supplies		Physical Value		Building Costs	Electrical Supplies	Living Costs
	Building	General	West	East	Light	Railways			
1914	100	101	94	100	96	99	97	92	98
1915	100	101	98	101	100	101	97	96	100
1916	104	102	126	123	122	116	118	122	126
1917	111	108	158	139	159	132	140	160	177
1918	130	128	166	154	174	159	159	166	194
1919	145	135	169	150	184	182	172	169	206
1920	208	175	196	169	203	234	214	194	226
1921	209	178	171	148	190	203	187	170	146
1922	195	168	162	130	171	180	172	162	148
1923	201	178	174	135	171	184	194	174	153
1924	222	185	173	126	170	179	200	172	149
1925	212	193	171	124	170	179	198	171	158
1926	212	197	...	120	...	...	198	170	...

	Distribution Transformers			Underground Cable		
	Composite	West	East	Composite	West	East
1914	100	105	100	100	109	120
1915	100	112	103	105	115	150
1916	109	120	107	167	123	192
1917	128	135	108	189	135	210
1918	157	155	110	213	150	227
1919	156	159	120	222	171	244
1920	166	162	131	218	201	237
1921	159	160	127	166	198	190
1922	137	155	119	181	189	158
1923	144	149	119	168	153	144
1924	136	147	124	139	145	130
1925	134	146	120	130	145	115
1926	134	144	...	130	145	116

Supplies.—Under supplies are included such items as construction steel, cement, brick, poles, lumber and coal. Typical examples in the East and in the West are charted. In both instances the individual cases chosen are companies having widespread operations over a large area. The curves in the chart, therefore, which follow the same general trend, picture the situation in the country as a whole.

Labor Costs.—The charts representing labor costs are based on the wages of representative groups of inside and outside workmen, including linemen, construction foremen, station shift engineers and office clerks. In the first two cases hourly rates are taken, weekly rates in the second two. A study of the various



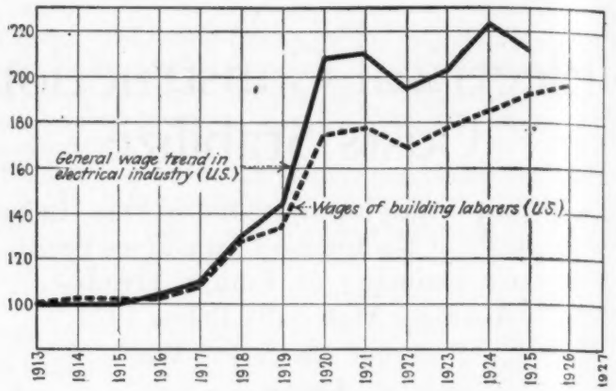
COST OF MISCELLANEOUS SUPPLIES

charts will disclose the fact that labor costs are the one group that have persistently avoided a post-war reduction. The trend has been almost steadily upward since the war period.

Physical Value of Property.—As is to be expected, there is a very definite similarity between the trends of physical values of properties and construction costs. The chart showing the variation in physical values of utility properties since 1913 is based on a study made recently by *Engineering News-Record*. The percentage changes in the values of 25 electric light plants and 25 electric railways are shown.

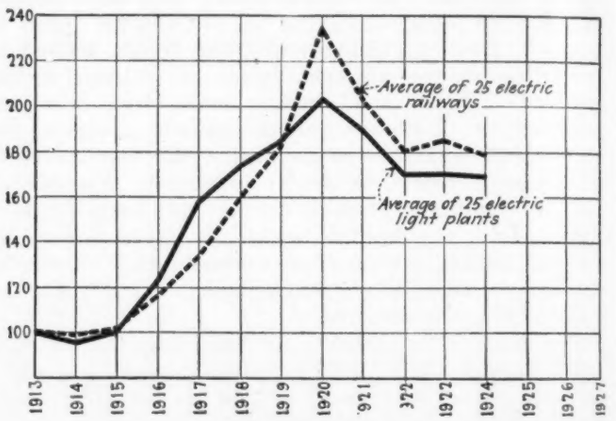
In the final chart is a comparison of the various cost factors in the electrical industry with general living costs and with the cost of electricity. Electrical building costs as a group apparently have struck a level higher than that of general living costs or electrical supplies, although the peak of that group was not as high as that of living costs in general. The cost of electricity, as computed by Bonbright & Company, has not shared the upswing experienced by the other costs and is now materially lower than in 1913.

A summary of the series on which the charts were based is given in the accompanying table.



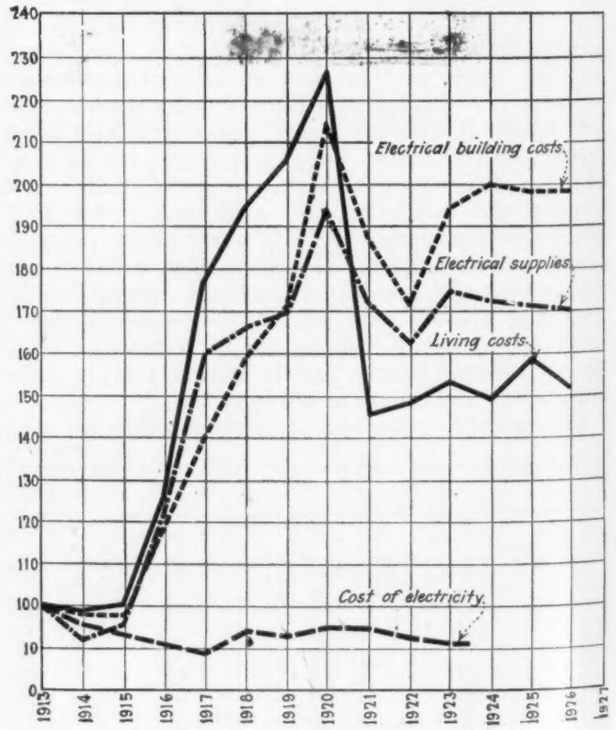
LABOR COSTS STILL TEND UPWARD

In contrast with the situation after previous periods of expansion, wages have refused to follow prices on the down-swing.



VARIATION IN PHYSICAL VALUE OF UTILITIES

Utility property values, based on replacement costs, follow prices downward from 1920 to 1922 and remain fairly stable thereafter.



ELECTRICAL COSTS AND COST OF LIVING

Improvements in the process of power production and distribution have been the chief factor in lower power costs.

Distinctive Features of Hydro-Electric Construction

By L. F. Harza
Consulting Engineer, Chicago

Time Relation of Design and Construction—A Recommended Procedure — Factors Which Determine the Schedule—Making Draft-Tube Forms Ready for Excavation — Grading Methods Distinctive—Progress Records

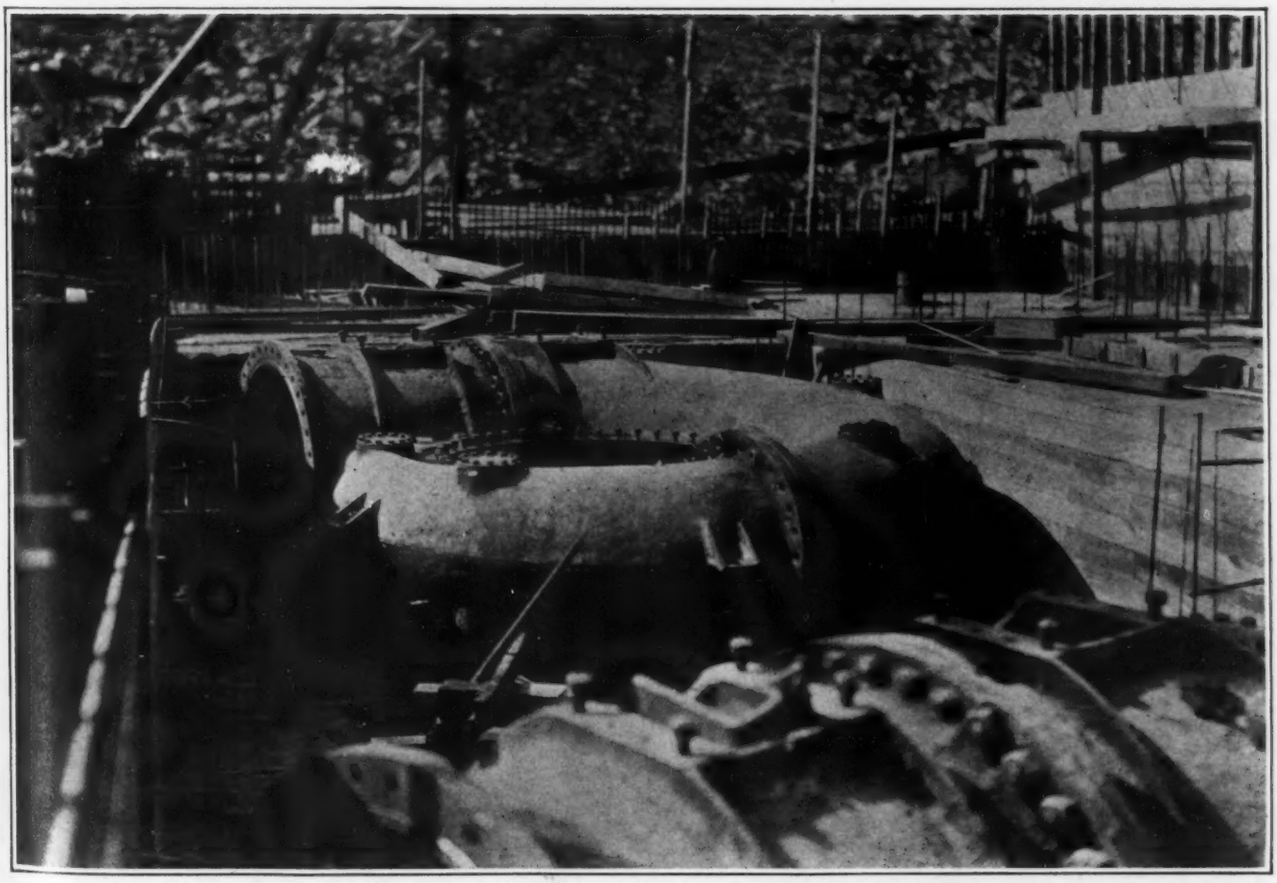
HYDRO-ELECTRIC projects vary so greatly in their characteristics that almost every type of construction equipment and method will be found if various types of projects are considered. The field is too large to cover thoroughly except in an exhaustive treatise, but a number of phases of hydro-electric construction are quite distinctive and require specialized experience. Some of these features will be discussed with the hope that the comments may be helpful to persons in the public-utility field who are planning or may eventually undertake hydro-electric development work.

Until equipment contracts have been awarded and details of equipment have been received it is impossible to complete the more elaborate design details of hydro-electric plant draft tubes, scroll cases, conduit runs, switch cells, etc. As a result there are several orders of sequence in which the development work can be initiated.

In order of desirability the plans are as shown in the following:

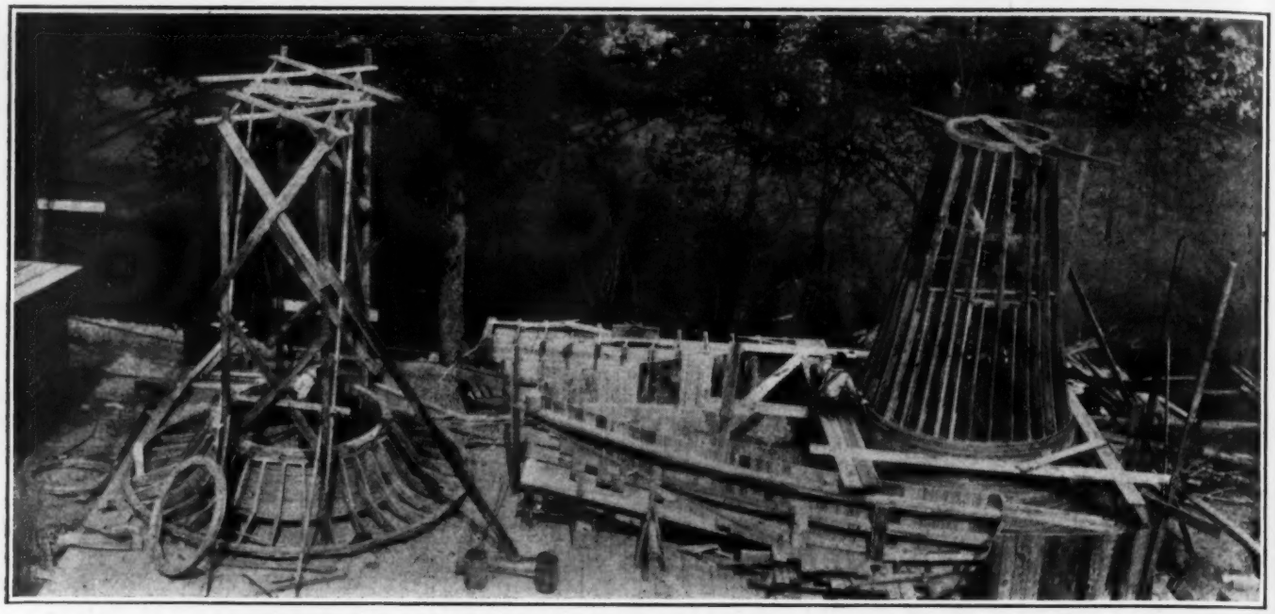
Plan A.

1. Complete the plans and specifications as far as possible without machinery details.
2. Buy the machinery and await designs of draft tubes, scroll cases, grout spaces, anchor bolts, holes, etc.
3. Award the general contract or start construction with company forces with full, available information in



CAST STEEL SCROLL CASE NEARLY READY FOR IMBEDDING IN CONCRETE

For low heads and large units it is frequently more economical to form the scroll case in the massive concrete foundations needed.



CONSTRUCTING DRAFT TUBE FORMS SIMULTANEOUSLY WITH EXCAVATION AVOIDS DELAY

While the excavation for the power house is proceeding the draft-tube forms are being constructed on a layout platform situated where it will not interfere with other construction. When the excavation is prepared, the forms are lowered into place, thereby saving the delay of constructing them in other than their final form on the foundation structure.

the hands of the contractor or company's construction forces.

Plan B.

1. Complete the plans and specifications as far as possible without machinery details.

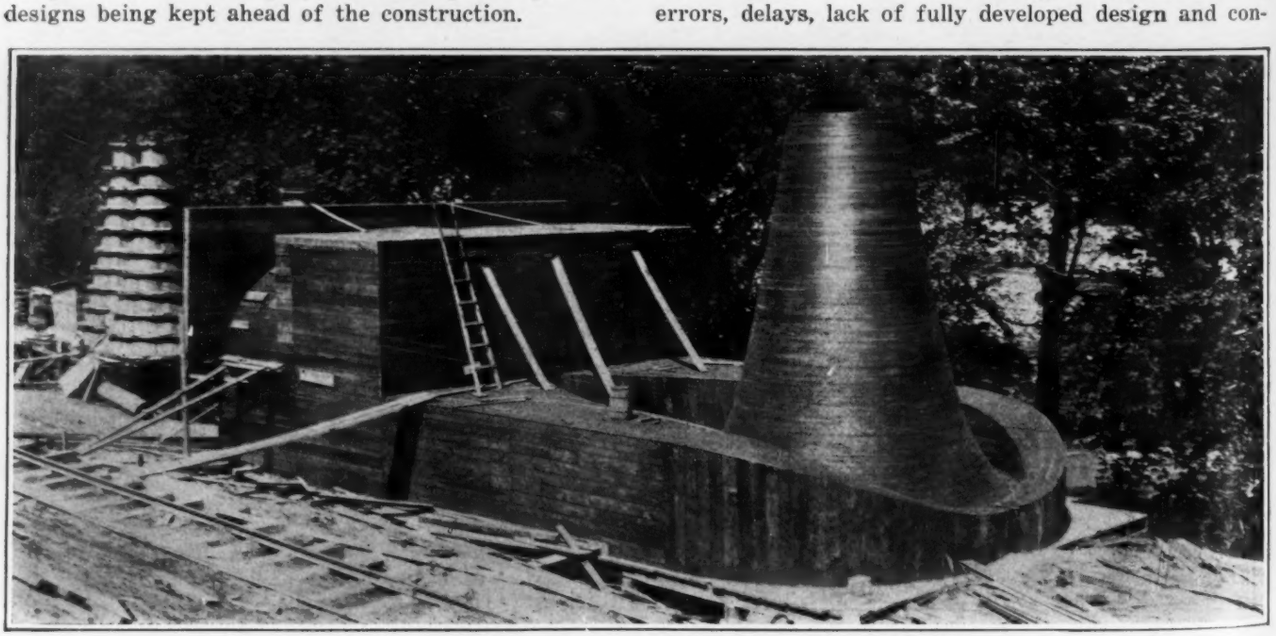
2. Buy the machinery and commence the construction work.

3. Complete those detail designs that are dependent upon machinery details such as draft tubes, etc., while the construction organization is building cofferdams and excavating the foundation.

Plan C.

Start the design, the construction and the purchase of machinery simultaneously, based only upon preliminary studies of the project, and depend upon the designs being kept ahead of the construction.

Of the foregoing plans of procedure, Plan A is of course ideal, as it permits a more definite contract to be awarded, not subject to ultimate controversy except with respect to changes in design that must at times be made to accommodate the unforeseen field conditions. Plan B is not generally unsatisfactory and is a more useful procedure than Plan A. Plan C is used altogether too often, sometimes by necessity, but is always unsatisfactory. It does not give the engineer a reasonable time to perfect his designs and therefore results in more field changes. It does not permit the contractor or construction organization to make a binding estimate of the cost. This situation results in divided responsibility, which is always wrong in principle. It also gives both engineer and contractor legitimate excuse for errors, delays, lack of fully developed design and con-

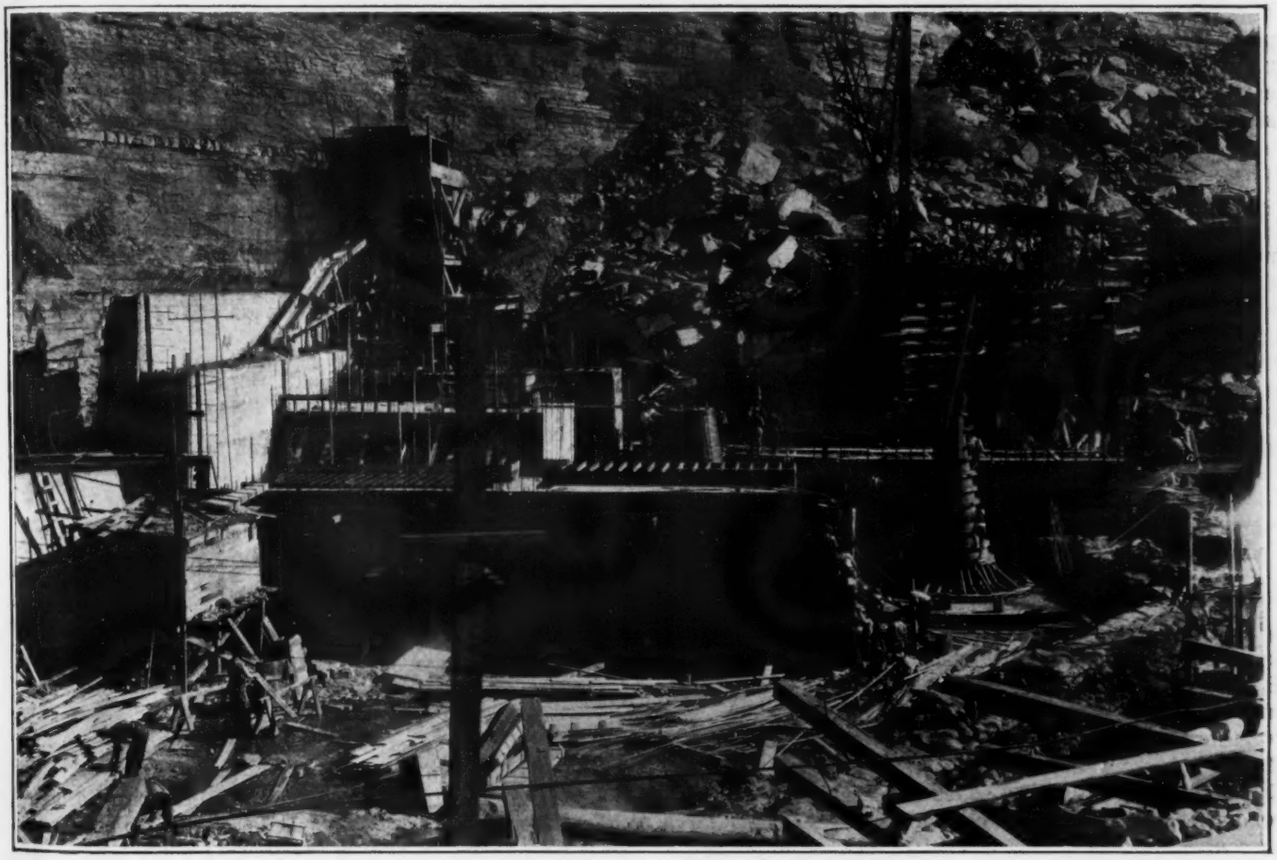


SECOND STAGE IN THE CONSTRUCTION OF DRAFT-TUBE AND CONE-CENTER FORMS

struction plans and is more than likely to result in contention and "buck-passing" among those whose co-operation is necessary for the maintenance of the proper progress.

A Program of Construction

An elaborate system of reservoirs, pipe lines, flumes, etc., is often involved in high-head projects, which may govern the time of construction of the project. In a low-head project, however, it is usually found that the power house proper (including the installation of machinery, switchboard, wiring, etc.) requires a greater time for its construction than does the dam. Therefore it is usually preferable to cofferdam the power-house area and start excavation for it ahead of any other portion of the work.



DRAFT-TUBE FORMS IN PLACE AND READY FOR POURING

Before the power-house substructure can be designed or the dimensions more than approximately determined the hydraulic turbines must be purchased in order to settle the draft-tube design, which the manufacturer of the turbine usually furnishes as a condition of its guarantee.

Since draft tubes occupy the lowest portion of the foundation or substructure and usually require very complicated forms, information thereon is required ahead of all other design information; hence the first move after a hydro-electric project is authorized should be to purchase the hydraulic turbines (which is usually done simultaneously with purchase of the generators). The manufacturer must then prepare the draft-tube outline drawings as rapidly as possible, frequently requiring some research in co-operation with the purchaser's engineer to obtain a mutually agreeable design. Upon receipt of the outline drawings the contractor must design and construct the forms for the draft tubes, preferably on an adjacent dry-land platform simultaneously with the construction of the cofferdam and the excavation of the power-house foundation. This simultaneous work is necessary in order that the draft-tube forms may be set in place either as units or in sections as soon as the foundation excavation is ready.

After construction of the draft tubes the scroll-case forms (if to be built in concrete) will soon be required and also all of the power-house substructure details, including the intakes, water passages and gate grooves, to permit the concrete work to proceed without interruption. While this work is being done a detailed layout of equipment is being made with the dimensions of all grout clearances and anchor-bolt holes for machinery, piping for various purposes, conduit layout for power and control cables, lighting and all similar details. Even in cases where the general design of the station is completed before the contract is awarded the design of such details as draft tubes, scroll cases and other water passages, anchor bolts, conduit layouts and similar details cannot start until the machinery, transformers and switchboard contracts are awarded. Therefore considerable pressure is usually required to complete the contracts if the progress of the contractor is not to be delayed.

The speed ring and scroll case, if built of metal, must usually be available as soon as the draft tubes are poured, which means at a very early stage of the work. Since the manufacturer cannot furnish the speed ring and scroll case without completing the remainder of the

turbine and assembling it completely in the shop before shipment, it is nearly as easy to obtain the complete turbine as merely the speed ring.

All of the foregoing conditions and requirements conspire to make the turbine manufacturer's part a rush job. Often the negotiations for the purchase of turbines or the award of turbine contracts, design of draft tubes (with any accompanying research if necessary) and manufacturer's delivery of turbines must be largely, if not entirely, completed during the interval required for the general contractor to build the cofferdams, unwater and excavate the power-house foundations and build the substructure up to the turbine level. The contractor usually rushes this portion of the work in order to get above the cofferdam as quickly as possible. Where the pressure thereby imposed on the turbine builder is too great, it is possible, by properly reinforcing, to build merely an outside wall or shell of the power-house substructure, including just enough to permit the substructure to go ahead and leaving out the entire central volume of concrete for subsequent construction of draft tubes and scroll cases.

Scheduling Construction Items for the Building of the Dam

Dams.—As a rule the general contractor is also under pressure in raising the dam foundations above cofferdam level, but this work is usually under his entire control. No intricate design is involved and no machinery has to be purchased and erected upon which the progress of general construction is dependent. However, dam construction is a field of activity in which the utmost attention must be given to a scientific study of the past performance of the river in order to determine the organization, schedule the work and decide on the type of cofferdams and type of construction equipment to employ.

Most rivers suitable for power development are subject to floods of such magnitude at certain seasons of the year that destruction of partly completed work will often result unless the work is carried to a stage that is free from hazard before the arrival of the floods. Hence the economical and safe construction of a dam usually requires a construction schedule so well worked out that it can be met by the construction forces with a degree of assurance approaching certainty. Storage dams must in general be scheduled for completion and ready for storage at the beginning of the high-water season, otherwise a long period of utilization, often a year, will be sacrificed awaiting another filling season.

Other rivers are subject to flood at almost any season of the year, in which case the type of structure and method of construction must be such as to avoid any loss other than that of time in the event of a flood at any stage of the work. Beyond a certain point rapid construction is seldom efficient and often very costly owing to the night and overtime work, excess equipment required and premium paid for rapid delivery, etc., but it is frequently an unavoidable handicap in the construction of dams.

Cofferdams.—For unwatering or exposing the river channel for excavation and foundation purposes, cofferdams may vary from a low ridge of sand bags or clay dumped by wheelbarrows to heavy rock-filled timber-crib structures approaching in stability the old types of permanent timber-crib dams and capable of withstanding overflow of any magnitude. A simple earth-fill cofferdam, involving little expense, can often be used for this purpose in a river where flood seasons are relatively definite, where the work can be scheduled without the requirement of undue speed and with reasonable certainty of reaching a safe stage before the arrival of floods. The more irregular and uncertain is the flood season of a river and the greater the pressure that must be exerted for completing the construction during the favorable conditions of the river the heavier and more expensive must be the cofferdams to meet possible emergencies.

Water Passages.—In the high-head developments of the West, the construction of the pipe line is probably the largest single item of most projects. These pipe lines are often in relatively inaccessible locations and must be erected upon very steep mountain slopes where the experience and equipment of the contractor are of utmost importance.

When scroll cases are built of cast steel, plate steel or cast iron and are merely imbedded in the concrete structure of the power house, the construction problem is relatively simple. However, the scroll cases for low heads and large units are often formed in concrete, because the massive foundation otherwise needed can usually be made for considerably less cost in this manner than when the scroll case is formed of metal. When this type of construction is employed, the problem naturally becomes much more complex, and specialized skill and talent are required on the part of the form layout foreman.

Excavation and Form Construction Performed Simultaneously

Draft-tube construction is becoming ever more complicated because of the increasing use of the symmetrical tube. The draft tube or a large portion of it must usually be formed in concrete. The forms for this work probably require the most highly specialized work in connection with hydro-electric construction. Moreover, the construction usually has to be completed under the greatest pressure, since the forms are the first needed after excavation, because of the delay in their design by complexity and since their outline is usually furnished by the manufacturer and cannot be made available to the constructor until 30 or 60 days after purchase of the turbines.

If draft-tube outlines and form designs can be completed in time, it is preferable in every case to construct draft-tube forms on special platforms on dry land while the excavation of the power-house pit is in progress. If the forms are built in place, the construction of the power house is greatly delayed. Moreover, this delay would increase the time necessary to keep the cofferdam in service, thereby increasing the time of pumping and the hazard from floods, all adding greatly to the expense of the structure.

Grading and Canals.—Occasionally a hydro-electric project requires work comparable with grading a railroad or highway, but more frequently it involves the construction of earth fills of considerable magnitude, which cannot be built by end dumping and usually not from a trestle dump nor in fact by most of the methods common to railroad grade construction. Commonly the fill must be built by the so-called dry-fill or hydraulic method. The dry-fill method requires spreading the material in layers (usually not more than 6 or 8 in. thick), sprinkling and rolling to compact the material

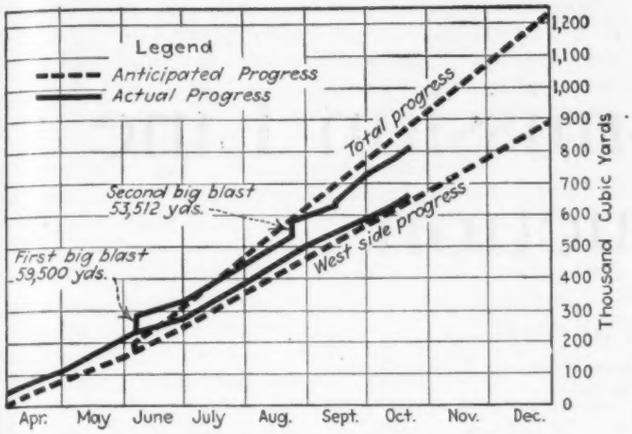


FIG. 5—ONE METHOD OF RECORDING PROGRESS

Frequently the mass of concrete poured, excavated material removed or fill placed is used as a measure of progress. Progress can also be indicated on drawings of structures by coloring or cross-hatching completed parts.

thoroughly and building up the structure in essentially horizontal layers. The material must be carefully selected, segregated and distributed, inasmuch as the material that is acceptable for one part of the fill is not suitable for another. As is well known, only certain kinds of materials will compact successfully under a roller.

Likewise for a hydraulic fill only certain types of material are suitable, preferably material carrying a considerable proportion of gravel to form the slopes.

Some Distinctive Problems

Material for earth fills must sometimes be taken from shallow borrow pits covering a considerable area of the river valley, although at other times it must be obtained from deep, high-level borrow pits. A shallow expansive borrow pit is usually handled by elevating graders and dump wagons or dump trucks, or by fresnos, slip or wheel scrapers for short haul.

One problem is that of delivering the material onto the surface of the fill, which is progressively increasing in elevation. This requires frequent adjustment of elevation of delivery roads or tracks. Trestle dumping is not usually applicable, although it is with some classes of material, in which case the dumped material is immediately spread into layers for rolling. All sway bracing of the trestle must be removed, as the fill builds up and the material must be settled around the trestle posts by water where it is not possible to compact it with a roller.

Where the material is of a gravelly nature, it often contains boulders too large to permit of rolling. Such boulders will have to be thrown out at the borrow pit or from the surface of the fill, as thorough compacting by rolling is absolutely essential for an earth dam built by the dry-fill method. Although fresnos are often used for spreading earth fill into layers for rolling as dumped from the car or dump wagons, road graders are found to spread the fill more evenly and probably cost no more to operate.

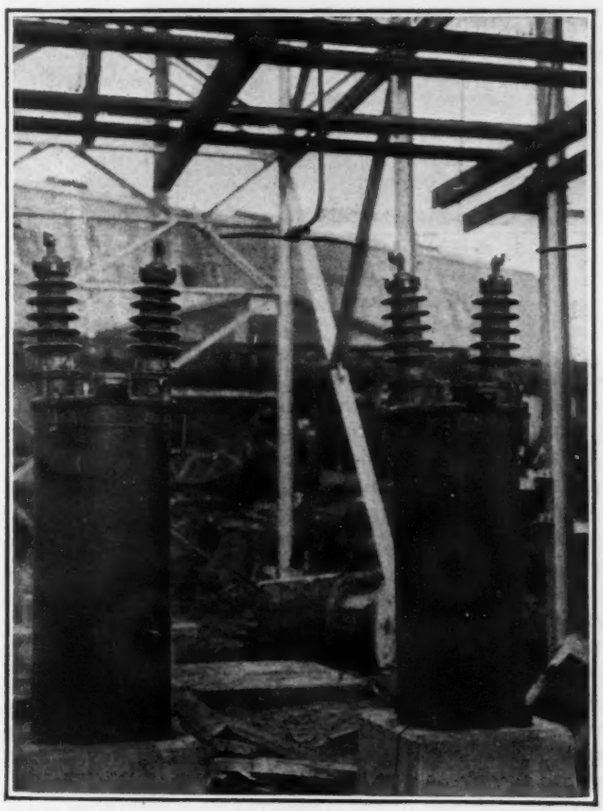
Rolling is often done with the usual steam roller and also frequently by horse-drawn or tractor-drawn rollers, improvised by filling a section of corrugated culvert pipe with concrete. The weight of the roller should not be less than two tons per linear foot and at least two rollings, usually three, are necessary on each layer, dependent upon the character of the material.

Transportation—Problems of highway and railroad construction and transportation often govern the location of high-head hydro-electric projects in the Western mountains. For such projects the provision of transportation facilities usually entails the expenditure of very large sums. The more prosaic Middle West or Eastern projects do not usually involve serious transportation problems, because of relative proximity to transportation or more favorable topography for extension of highways or railroads.

Progress Charts—Progress diagrams or charts are of many forms. When completed unit quantities are a fair indication of accomplishment, the progress on concrete, excavation or fill can well be represented by mass curves like those shown, in which the dotted curve represents the expected progress and the full line the accomplished progress. More complicated work can best be shown by cross-hatching or coloring upon a drawing of a given structure the portion completed as of the date of the chart.

Overcoming Vibration by the Use of Flexible Copper Bus Leads

TO ELIMINATE the effects of vibration from mechanical causes upon connections to potential transformer terminals in a 38-kv. New England switchyard, the leads from the outdoor bus taps are cut off short



PROTECTING POTENTIAL TRANSFORMER TERMINALS FROM EFFECTS OF MECHANICAL VIBRATION

within about a foot of the bushing terminals and the circuit completed by flexible copper leads of stranded conductor. The accompanying view shows this construction in process of erection before the flexible leads have been installed.

220-Kv. Transmission Line Construction

By J. B. WHEELER
Superintendent of Construction Southern California Edison Company
Los Angeles, Cal.

BUILDING A ROAD ALONG THE VINCENT 220-KV. LINE

CHANGES in design of high-voltage transmission lines in the past few years, such as higher voltages, greater kilowatt capacities, conductors twice the size and weight of those used in former lines, correspondingly heavier steel towers and the elimination of 90 per cent of the anchor towers have brought about changes in construction methods and practice that have in many respects simplified actual construction work, resulting in greater progress, higher efficiency and lower unit costs. The third 220-kv. transmission line, known as the Vincent line, now being built by the Southern California Edison Company, will serve to bring out some of the changes in methods and practice of constructing lines referred to. The Vincent line will be 223 miles in length and will serve as a third 220-kv. link between the Big Creek hydro-electric plants in central California and receiving substations at Eagle Rock and Laguna Bell, near the city of Los Angeles. The estimated cost of the completed line, including some substation work, is $11,000,000.

The efficiency and flexibility of transmission-line construction organizations of today is shown by the completion and placing in operation of a 24-mile section of this line in exactly 24 days in order to meet an emergency. This is two and one-half times the normal rate at which construction of the line was being carried on before the emergency arose, and although high-speed work is not considered good practice, it does show what is possible with refinements of methods, apparatus and organization.

Aërial Survey.—Aërial surveys are of great value where transmission lines follow highly developed agricultural territory; however, the value of aërial surveys over rugged mountain country compared with the cost of obtaining them is not so favorable. The aërial surveys were confined to a ten-mile section of line through highly developed agricultural territory.

Right-of-Way.—The right-of-way for transmission lines is obtained either in fee or through easements, depending upon the territory through which the line is routed. Where the territory is highly developed from an agricultural or industrial point of view it is desirable to obtain all rights-of-way in fee. In cases where the line is to be located through mountainous country and undeveloped territory, easements for right-of-way are obtained. In so far as possible the line was run through mountainous country to obviate difficulties of this nature.

Road Work.—One hundred miles of new roads is being constructed to establish a line of travel along the

transmission line for construction, patrol and maintenance. As communication for operating purposes is most important, the telephone line follows the road very closely. For the first nineteen-mile section of transmission line 40 miles of continuous mountain road was constructed with a width of 9 ft. and prevailing maximum grades of 10 per cent and short pitch grades of 12 to 15 per cent. The construction of this road necessitated moving 400,000 cu.yd. of earth and rock.

The method of road construction consists in establishing a foot trail, which is widened to a 5-ft. tractor trail by manual labor or with compressors, jackhammers and blasting powder. From this point 30-hp. tractors, road rippers and 8-ft. leaning wheel type graders are used to widen the tractor trail to a 9-ft. road.

Transportation of Materials to Job.—The major materials, such as steel, cable, insulators, hardware and telephone materials, are received at the nearest railroad point, where assorting yards are established and the steel towers assorted into complete units. From these points, which are located from 10 to 30 miles from the nearest point on the transmission line, delivery of all materials is handled by means of two and one-half-ton pneumatic tire trucks equipped with duplex rear tires and chain drive.

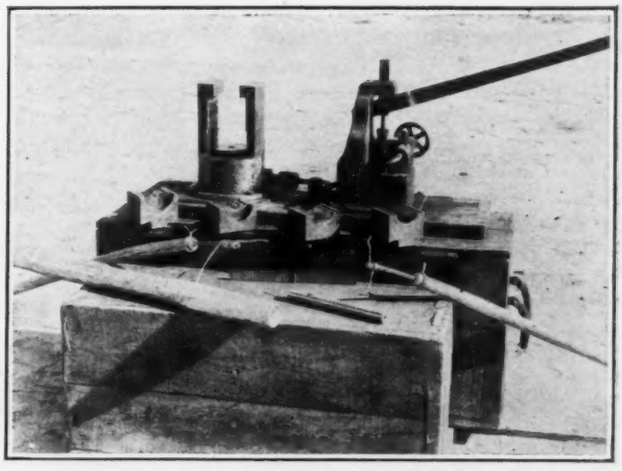
Where the grades from the main line of travel to the tower locations are prohibitive for the truck alone, 30-hp. tractors are used for auxiliary power. In a few cases it becomes necessary to transfer loads to stone boats or trailers and take to locations by means of tractors or lines from a 10,000-lb. winch truck. The aluminum cable is received on reels weighing two and one-half tons. Delivery of cable reels to points along the line not readily accessible to trucks is made by means of reel dollies attached to 60-hp. tractors.

For the delivery of such materials as blasting powder, culverts and road cribbing, special narrow tread cross-reach trailers are attached to 30-hp. tractors. The particular advantage of this form of trailer is that it can be operated over a 5-ft. tractor trail and on a very small radius of curvature due to its double end steering principle. For delivery of miscellaneous materials such as insulators, hardware, hot lunches and cookhouse supplies one-ton pneumatic tire trucks are very well adapted.

Tower Erection Methods and Practice.—The weight of a standard tower is approximately four and one-half tons exclusive of stub steel, which weighs approximately one ton. Tower extensions weigh one to two tons according to the type of extension used. The stubs are set by means of engineer's level and transit. The lower section of tower or extension, as the case may be, is then assembled in panels and hinged up into place on special case-hardened tool steel bolts by means of power furnished by a direct pull of the truck or from the 10,000-lb. winch mounted on the truck. With the extension or lower sections of the tower in place the structure is completed by hoisting assembled panels into place.

When special conditions prevail where the rate of tower erection is three to four times greater than the normal rate of speed, such as occurred recently in the building of 24 miles of line in 24 days, where the erection of 100 steel towers was completed in seventeen days, the tower-erecting crews are built up rapidly with inexperienced men, whose function it is to erect only the extension or first section of tower and move to the next location, leaving the completion of the tower to more experienced tower erection crews that have been drilled and trained for team work in erection work. A crew of sixteen men, including truck driver and gang foreman, have under favorable conditions erected standard towers weighing four and one-half tons in three and one-half hours.

Wire-Stringing Methods.—More important changes have taken place in the method and practice of stringing aluminum conductors in the last few years than in any other phase of transmission line construction. An outstanding advance in this work is the application of specially designed aluminum roller-bearing sheaves attached directly to the insulator strings that support the conductor. These sheaves, which are as near frictionless as possible, have brought about long tension pulls of four to five miles with ease, as the free run of the cable over the sheaves allows the conductor in the various spans to adjust itself quickly and does not pro-



EQUIPMENT USED IN SPLICING 1,333,000-CIRC.MIL STEEL CORE ALUMINUM CONDUCTOR

duce excessive load on the conductor in spans nearest the point where the pull is made.

A direct drawbar pull from 60-hp. tractors is used wherever possible. Where this is not feasible, the cable is pulled to tension from the drum of the winches that are mounted on the 60-hp. tractors and also on the two and one-half ton trucks. Where the difference in elevation of towers is such that the cable has a tendency to run, two-bolt aluminum chock blocks are bolted to the conductor next to the sheave to hold the cable in place while adjustments are made in adjacent spans. Direct telephone communication between the various control stations and the pull point makes this operation very simple. Wherever possible the transfer of the conductor from the stringing sheave to the suspension clamp is made by means of a line from the winch truck. In other cases one-and-a-half-ton chain blocks are used and also three-ton jacks, designed on the principle of turnbuckles, where the vertical loads are heavy.

In stringing out conductors in uncultivated, flat country the reel is placed on a track and the conductor strung out along the ground for the two outside conductors only. The winch truck is then used to raise the insulators, sheave and conductor to the crossarm all in one operation. In the case of the center conductor in the flat country, the reel is put on jacks and mandrel and the cable pulled out and passed through the tower.

In rough mountain country the three conductors are usually pulled out at the same time, being attached to a

bridle. A $\frac{5}{8}$-in. plow steel cable with a direct pull from the niggerhead of a winch truck is used for pulling out cable. Great care must be exercised to keep the abrasion of cable to a minimum and for this reason no more than one reel is pulled out at a time. Through rocky country great care is used in protecting the aluminum cable from damage. In pulling to final tension with a winch truck the $\frac{5}{8}$-in. plow steel cable is always attached to the drum of the winch and not over the niggerhead. This regulation is a matter of safety during construction. In order to get the $\frac{5}{8}$-in. plow steel cable across deep canyons and inaccessible country a $\frac{1}{4}$-in. plow steel cable is taken across by hand. This light $\frac{1}{4}$-in. steel cable is a big improvement over $\frac{1}{2}$-in. and $\frac{3}{4}$-in. rope hand lines.

Dead-end connections, of which there are very few to be made, are made up and completely assembled on the ground after the conductor has been pulled to tension, marked and let back to the ground. When the complete assembly has been made on the ground, the conductor and assembly are pulled up to the tower and the single bolt connection made to the tower. This eliminates the time and hazard of working men on ladders suspended in midair from the tower and conductor. All conductors are sagged in by means of a transit, which as a rule is attached to the leg of the tower by means of special brackets.

Wire-Splicing Methods.—The splicing of the aluminum conductor, which has an area of 1,333,000 circ.mil with an outside diameter of $1\frac{1}{4}$ in. and a steel core 0.42 in. in diameter, must be very carefully done in order to obtain the proper strength of the splice. For this operation men are selected for their dependability, accuracy, thoroughness and ability to produce the highest type of workmanship. All splices are numbered and a record kept of the number, location and by whom made. Splices occur approximately every 3,000 ft., giving a total of approximately 1,200 splices in 223 miles of line.

The steel core is spliced with a soft steel sleeve 11 in. long compressed on the core with a 100-ton hydraulic press. This joint is then waterproofed and the cast-aluminum sleeve, which is 30 in. long, is put in place and compressed over that portion of the sleeve that is in contact with the aluminum conductor.

Time and Labor-Saving Methods.—The following are some of the more important time and labor-saving devices and methods that are used in construction.

Portable telephones and duplex telephone wire for transmitting of signals in stringing conductors, thus eliminating a large crew of signal men formerly stationed in the towers. The use of aluminum sheaves with roller bearings for stringing conductors, making long tension pulls practical and very economical. The use of insulator strings for supporting the stringing sheaves, which were formerly suspended from steel cables. The use of the winch truck for hanging insulators, sheaves and conductors in one operation; for transferring the conductors from the stringing sheaves to the suspension clamps, and for passing splices past the sheaves in pulling out conductors. The use of 60-hp. tractors with a direct drawbar pull for pulling out cable and also for final tension pulls. The assembly of complete dead-end units on the ground and hoisting the complete unit to the tower, requiring but a single connection to be made at the tower. The particular phase of this operation is the elimination of all ladders suspended in midair and the hazard of working men under these conditions. The use of $\frac{1}{4}$-in. plow steel cable for man handling across canyons and inaccessible places has proved very successful.

TOWER ERECTION FOR 220-KV. TRANSMISSION LINE

Field Organization.—The field organization on an average consists of 500 to 600 men, with approximately two-thirds of the organization on transmission line construction and one-third on road construction. The transmission line work is divided into sections of approximately 20 miles under the supervision of camp foremen, while special branches of the work, such as transportation, materials, mess halls, timekeeping and accounting, are in charge of department heads specializing on each branch of the work.

Time and Cost-Keeping on the Job.—All timekeeping, payrolls, accounting and unit cost reports are handled in the field by the field headquarters organization.

Commercial Activities and Public Relations

Savings Through Power Factor Correction

BY E. T. ANDERSON
Electrical Engineer Board of Water and Electric Light Commissioners, Lansing, Mich.

IN AUGUST, 1923, the Board of Water and Electric Light Commissioners of Lansing, Mich., put into effect a new power factor clause, which is shown in Table I. The multiplier constants as used in this clause were worked out by taking into consideration the losses due to the current in the lines, transformers and generating equipment and also the investment charges brought about by the higher requirements for the lower power factor loads.

The following analysis of the data pertaining to one customer gives an idea of the results obtained and the cost thereof. It is also of considerable interest to note that since the adoption of the power factor clause the system power factor has been raised from an average of 67 per cent to an average of 82 per cent.

Case I, Table II, gives the data for the customer under consideration for the year from October, 1922, to September, 1923, with the bills as they would have been under the new rate with the power factors as they actually were. Case II gives the same data with the bills computed on the basis that the power factor was the same as obtained in the following twelve-month period. A comparison of these two shows a saving of approximately $23,800 to the customer if the necessary corrective apparatus had been installed.

Case III and Case IV give the data and the bills according to the conditions that actually existed during the following year, comparing them with those which would have obtained if the power factor conditions were the same as for the preceding year. These show a saving of approximately $22,200. This saving means that the corrective apparatus paid for itself the first year, which is quite an inducement and talking point in favor of the customer.

Case V and Case VI show the bills as they would have been under the new rate with no power factor clause in effect. A comparison of Cases V, VI and III shows that the utility lost a possible revenue of $6,000 for the first year and $5,000 for the second year. Expressed in another way, the utility is paying from $5,000 to $6,000 per year for the benefit of the corrective apparatus. On an allowance of 15 per cent for annual charges, the utility would be justified in an expenditure of not more than $40,000 to produce the same result.

Analysis of power demands shows that the additional capacity required would be approximately 1,400 kva., making the necessary allowance for overload conditions. The additional transformer, line and generator capacity could not be installed for anywhere near $30 per kilovolt-ampere, hence the utility is getting the additional capacity at a much lower price than it could have it installed. No credit has been given for the decreased losses in the system, which is also an appreciable gain to the utility. Much better regulation and service are obtained with the higher power factor, but the value of these is hard to determine.

The question may be raised that the utility could install the necessary corrective equipment. This could be done very easily by the utility, but one important advantage would be lost. When the customer has to provide the corrective equipment, it is to his advantage to see that his equipment is properly chosen and loaded with the power factor feature in mind. If the customer had nothing to lose or gain, he would pay very little attention to these vital points, and it would cost the utility a great deal more to produce the same results.

TABLE I—POWER FACTOR CORRECTION SCHEDULE

Definition and How Obtained

Power factor shall mean the average power factor maintained by the customer during the month or period of time for which the demand is measured and shall be determined by the reactive component meter method and shall equal kilowatt-hours, divided by the square root of the sum of the squares of kilowatt-hours and reactive kilowatt-ampere-hours.

Method of Application

The multiplier constant given below corresponding to the power factor as found by the above method shall be applied to the actual measured monthly demand and the actual measured monthly consumption of electric energy. The result in each case which will be known as billed demand and billed kilowatt-hours shall be the basis for rendering customer's bill.

TABLE OF CONSTANTS

Per Cent Power Factor	Mult. Constant	Per Cent Power Factor	Mult. Constant	Per Cent Power Factor	Mult. Constant	Per Cent Power Factor	Mult. Constant
100	0.9330	82	0.9916	64	1.1062	46	1.3184
99	0.9356	81	0.9958	63	1.1154	45	1.3330
98	0.9382	80	1.0000	62	1.1246	44	1.3498
97	0.9408	79	1.0052	61	1.1338	43	1.3666
96	0.9434	78	1.0104	60	1.1430	42	1.3834
95	0.9460	77	1.1056	59	1.1538	41	1.4002
94	0.9490	76	1.0208	58	1.1646	40	1.4170
93	0.9520	75	1.0260	57	1.1754	39	1.4362
92	0.9550	74	1.0324	56	1.1862	38	1.4454
91	0.9580	73	1.0388	55	1.1970	37	1.4746
90	0.9610	72	1.0452	54	1.2085	36	1.4938
89	0.9646	71	1.0516	53	1.2222	35	1.5130
88	0.9682	70	1.0580	52	1.2348	34	1.5348
87	0.9718	69	1.0658	51	1.2474	33	1.5566
86	0.9754	68	1.0736	50	1.2600	32	1.5784
85	0.9790	67	1.0814	49	1.2746	31	1.6002
84	0.9832	66	1.0892	48	1.2892	30	1.6220
83	0.9874	65	1.0970	47	1.3038	..	.....

TABLE II—POWER FACTOR DATA AND COMPARISONS

Case	Period	Cons. Kw.-Hr.	Av. Kw. Demand	Actual Av. P.F.	Av. Est. P.F.	Billed Kva.	Demand Charge	Bill, Kw.-Hr.	Energy Charge	Total Bill
I.	October, '22—September, '23.....	11,476,000	4,230	0.657	.....	4,620	$84,352.50	12,505,600	$138,508.65	$222,861.15
II.	October, '22—September, '23.....	11,476,000	4,230	0.657	0.873	4,123	75,000.00	11,129,061	124,054.84	199,054.84
III.	October, '23—September, '24.....	10,187,300	4,224	0.873	.....	4,093	74,875.50	9,913,552	111,258.53	186,134.03
IV.	October, '23—September, '24.....	10,187,300	4,224	0.873	0.656	4,613	83,984.00	11,157,303	124,351.68	208,335.68
V.	October, '22—September, '23.....	11,476,000	4,230	0.657	.....	.....	77,346.00	.....	127,695.00	205,041.00
VI.	October, '23—September, '24.....	10,187,300	4,224	0.873	.....	.....	76,967.00	.....	114,216.00	191,183.00

Digest of Electrical Literature

Hydro-Electric Development and Steam Equipment

History of Steam Turbo-Generators. — K. THIELSCH. — In this illustrated article the author records chronologically the development of steam turbo-generator sets from the beginning in 1902 up to the present time, dealing with the design and manufacture of one German concern. The prime-mover end only is considered. Statistics indicate that the installed capacity of turbines made by this firm had risen from 200,000 hp. in 1902 to 8,000,000 hp. in 1925, with a unit output of up to 75,000 hp. in one drum. The original high speeds decreased gradually until lately. Now, owing to better material and the vast engineering experience of the past, higher speeds of up to 3,000 r.p.m., even for very large turbines, are being chosen with absolute safety and reliability. The savings due to increased speed are very remarkable. For a 20,000-kva. turbine set the material required for 1,000, 1,500 and 3,000 r.p.m. is respectively as fourteen to ten and a half to six. The article contains 41 photographs and drawings.—*A. E. G. Progress*, June, 1926.

Generation, Control, Switching and Protection

Large Synchronous Condensers.—M. DONTREIX.—To the Gennevilliers power-supply system of Paris were recently added two 7,000-kva. synchronous condensers, installed at the Billancourt substation. To keep dimensions and costs to a minimum, these machines were designed with six poles and the unusually high speed of 1,000 r.p.m. Each of the machines can generate 7,000 kva. or absorb 3,500 kva. reactive current. The stator is wound for 10,000 volts at 50 cycles. The machines are totally inclosed and self-ventilated. A 550-hp. synchronized induction motor serves as starting motor at one end of the generator shaft, while an exciter is fastened to the other end of the shaft. A cross-sectional drawing of the machine is given. The same French firm which built these two condensers has furnished recently similar machines of 8,000 kva. and 15,000 kva. capacity to the French Midi electric railway system. — *Revue Générale de l'Electricité*, July 17, 1926.

Rectification of Alternating Currents with Steel-Inclosed Mercury-Arc Power Rectifiers and Their Auxiliary Devices. —OTHMAR K. MARTI.—The fundamental theory of these rectifiers is discussed, touching only slightly upon the physical phenomena, but treating particularly of the theory involved in the practical applications. The effects of various factors on the rectifier characteristics and operation are dealt with, and the methods used for calculating the relations of voltages, currents, transformer ratings, etc., are given and tabulated. Latest developments of the rectifier proper, as well as the auxiliary devices, are mentioned. The preparation of the rectifiers for service and their operation are described, and special attention is given to the numerous advantages attained by the use of rectifiers in substations. A new method of ignition and excitation, lately developed, which has proved to be extremely serviceable in practice, is described and illustrated in detail.—*Journal of A.I.E.E., September*, 1926.

Transmission, Substations and Distribution

Influence of Voltage Harmonics on Power-Factor Correction by Condensers.—EDWARD HUGHES.—When an inductive load has connected in parallel with it a condenser of capacity computed to give unity power factor on the assumption of a sine-wave emf., the desired correction is not secured if the voltage wave contains harmonics, since the higher-frequency components are practically 90 deg. leading and are not balanced by corresponding lagging components. This problem the author investigates analytically. He arrives at certain conclusions, among them the following: (1) The power factor of a system having harmonics in the voltage wave cannot be increased to unity by means of condensers. (2) When a consumer is being charged on the kva. of maximum demand as indicated on a demand meter, he is penalized by the presence of harmonics in the condenser current, particularly if the demand meter is of the induction type. (3) When the power factor is taken from a power-factor meter or from the ratio of meter readings, the consumer may obtain practically full benefit from the installation of condensers.—*Engineering (England)*, Aug. 13, 1926.

Sectionalizing of Mine Circuits.—E. L. HOUGH.—This paper deals with the character of mine electrification, enumerates the many advantages of sectionalizing mine distribution systems and discusses in detail automatic reclosing feeders.—*General Electric Review*, September, 1926.

Damping Coefficient of the Synchronous Machine.—L. DREYFUS.—With the present trend of superpower systems, where two or more generating plants are tied into one large power bus, the damping momentum of synchronous machines becomes an important factor. In case of sudden large changes of load on such a system hunting of power may occur. The damping of these oscillations decreases with increasing distance between generating centers, so that the amount of damping left may not be sufficient. Theoretically the coefficient of damping may become negative, and instead of abating the oscillations, they may increase. The present long treatise is a highly theoretical investigation of this important problem, published in two parts. It is shown first that vectorial representation of the hunting condition is just as possible as vectorial representation of the stationary operation, and from these newly developed vector diagrams an elaborate mathematical analysis is derived. At the beginning a synchronous machine with uniform air gap is assumed. It is pointed out that without cross field and under certain load conditions the damping momentum may actually become negative. To the damping of the generator is then added the damping momentum of the line, and it is explained how the latter rises with increasing load. In the second part the assumption of the uniform gap is dropped and actual conditions of salient field poles are introduced. The resulting complex formulas are compared with the equations in the first part of the paper.—*Bulletin de l'Association Suisse des Electriciens*, July, 1926.

Units, Measurements and Instruments

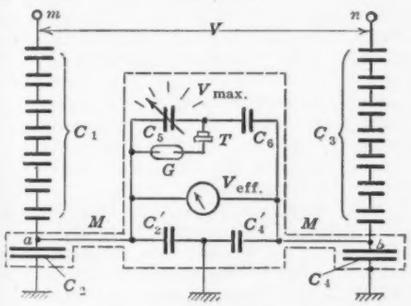
Some Aspects of the Dielectric Loss Measurement Problem.—B. W. ST. CLAIR.—This paper points out some of the difficulties of making accurate power measurements at very low power factors. It deals with the lack of reference standards of known and constant power factor, especially for moderate-sized samples and at high voltages. It also points out that a method of measuring an added loss as a check on the accuracy of a given test outfit is not a check at all, although it has been used as such in several instances. Reference is made to calorimetrical methods of calibrating a testing outfit and to special forms of resistors that have very low time constants and are suitable for this class of test work.—*Journal A.I.E.E.*, August, 1926.

Principle Governing the Distribution of Current in Systems of Linear Conductors.—F. WENNER.—In a system of linear conductors in which the current in every branch is proportional to the impressed electromotive force the current in any branch is that which would result should an electromotive force equal to the potential difference which would appear across the break were the branch opened be introduced into the branch and all other electromotive forces be removed. The use of this principle, according to the author, leads to a material simplification in the solution of many of that class of problems, for which it is generally considered that a solution may be obtained only by the application of Kirchhoff's laws.—*Bulletin No.* 531, *United States Bureau of Standards.*

Problem of the Spherical Condenser. —A. RUSSELL.—Methods are given of computing the capacity of a spherical condenser when the bounding spherical surfaces are not concentric. Methods of calculating the attraction on the inner sphere and the maximum potential gradient in the field between the two shells are given. The results obtained are of use in calculating the capacity coefficients of spherical electrodes. They are useful also when measuring by standard methods the inductivity, the thermal conductivity and the electrical conductivity of homogeneous substances.—*Journal of Institution of Electrical Engineers (England)*, July, 1926.

Mechanism of Breakdown of Dielectrics. — P. L. HOOVER. — This is an abridged report of a critical study which is being made of existing theories of dielectric behavior in an attempt to obtain a working hypothesis that more nearly meets the stringent requirements of experimental facts. The logarithmic formula is shown to give erroneous results if applied to high-voltage cables when they are operating under high stress, and the gradient in a cable, it is indicated, must be calculated from the volt-ampere characteristic of the dielectric, when stresses above the elastic limit are used.—*Journal of A.I.E.E.*, September, 1926.

High - Potential Voltmeter. — A. PALME.—An arrangement of instruments is described in this paper which permits an accurate and safe direct measuring of potentials of up to 860 kv. Essentially the apparatus comprises two specially designed seven-stage condensers with large toroidal top shields. The high potential is connected to the uppermost metal layer of the top condenser. If 500 kv. is applied, the last metal layer will show



HIGH-POTENTIAL VOLTMETER CONNECTIONS

about 800 volts potential. This is carried in a shielded wire to a multicellular static voltmeter, indicating effective voltage, and to an arrangement of smaller condensers and a calibrated vacuum tube or telephone. Parallel to the latter two is connected an adjustable condenser (see diagram), the moving element of which carries a pointer across a scale graduated in kilovolts. This condenser is turned up to the instant when the vacuum tube shows a glow. The indication on the scale is the crest value of the measured voltage. In the second part of the paper are described auxiliary high-voltage condensers with highly compressed gases as dielectric.—*Elektrotechnische Zeitschrift*, July 29 and Aug. 5, 1926.

Motors and Control

Rotary-Converter Equipments.—D. I. SCHUHMACHER.—Written primarily for the consulting engineer and the operating staff of a substation, this thoroughly practical article contains a great many general data on modern rotary-converter installations, their features, operation, starting methods and most economical layout. Particular stress is laid on voltage and power-factor control. A combination of converter and induction voltage regulator is recommended for wide voltage range. Rotaries for more than 500 volts are usually built with commutator flashboards and are controlled by quick-opening circuit breakers. The properties of rotaries to operate with leading power factor are explained from practical examples. On a diagram is shown a typical installation of a rotary which serves a light and a railway feeder. Finally the advantages and disadvantages of rotaries, motor-generators, cascade converters and mercury-arc rectifiers are enumerated.—*A.E.G. Progress*, June and July, 1926.

Rolling-Mill Drive.—A German concern received an order for the electrification of a Japanese steel rolling mill which included the drive for a 33-in. reversible blooming roll. The main motor is a 1,600-volt direct-current machine with an output of 4,000 kw. to 13,200 kw. and speeds between 66-r.p.m. and 195 r.p.m., with a peak torque of 195 metric tons. The control of this motor is accomplished from a four-machine flywheel set of the Leonard-Ilgner type. This set in turn receives its excitation and regulation from a group of five machines on one shaft. The complete diagram of the installation is given in the paper. Operation began twelve months after placing the order. —*A.E.G. Progress*, June, 1926.

Electrical Equipment of a Motor Ship. — E. SCHMIDT. — The 8,000-ton Diesel-motor-propelled ship *Hinnoy* is equipped with electric drive for all of its auxiliary machines, and the energy needed is generated by three 66-kw. Diesel-electric sets. These are specially designed for marine service and are of the two-cylinder, single-acting, four-cycle type, running at 400 r.p.m. Each motor set drives a compound-wound, 225-volt direct-current generator. When in port all three machines are in operation, but only one set is kept in operation while at sea. The equipment comprises twelve winches, one steering drive, four pumps, one machine-shop motor, one lighting converter, one radio converter and one 9-kw. emergency Diesel-electric generating set.—*A.E.G. Progress*, July, 1926.

Traction

Catenary Mountain Road.—F. HORSCHITZ.—Access to the much-frequented Rax Mountain in southern Austria has been greatly simplified by the recent completion of a suspension-car railway to its summit. From the valley station (1,750-ft. altitude) to the top (5,000-ft. altitude) a straight right-of-way was cleared, along which were erected four 100-ft. steel towers. These carry two heavy steel cables of 2-in. diameter, kept under tension by a weight of 34 tons attached to each at the valley station. The cables suspend two small cabins, holding 27 passengers, each of the cabins being attached to a 1-in. pull cable, ending at the top station on drums of winches. As one car travels to the top the other one descends. The average incline of the road is 46.6 per cent. The winch is driven by a 64-hp. direct-current motor, controlled from a Ward Leonard set in conjunction with a floating storage battery. Two 70-hp. Diesel-engine-driven dynamos, one of which is a standby, provide the required energy. The entire equipment is installed at the station on the summit. A ten-minute ride brings the tourist from the valley to the top of the mountain. Through the grounded suspension cable and the insulated pull cable a permanent telephone connection is maintained between the attendant in the cabins and the operator of the winch. Automatic and semi-automatic safety features are part of the equipment.—*Elektrotechnik und Maschinenbau*, Aug. 1, 1926.

Telegraphy, Telephony, Radio and Signals

Safety Rules for Radio Installations. —Previous editions of the National Safety Code have been published in complete form. The fourth edition is being issued not only as a whole but also as separate publications dealing with the several subjects involved. The fourth edition has been augmented by Part 5, dealing with radio installations, and it is this part which is here under notice. It contains rules which have been formulated and approved by a sectional committee organized according to the rules of procedure of the A.E.S.C.—*Handbook of the Bureau of Standards, No. 9.*

Miscellaneous

Economic Possibilities in Transcaucasia.—A. LUDIN.—On the southern slopes of the Caucasian Mountains between the Black Sea and the Caspian Sea is a part of Russia which is rich in agricultural and mineral resources. High-grade timber lands abound, mulberry trees make possible a production of 400 tons of silk annually, and about one-quarter of Russia's cotton production is centralized in this section. Four large oil fields, the largest at Baku, supply excellent crude oil. The manganese mines at Tschiatury are among the largest in the world. All of these industries require power, and a gradual electrification of this area is taking place. An ample supply of water power helps this transformation. More than 2,000 oil derricks in and near Baku are now driven electrically. From an annual consumption of 66,000,000 kw.-hr. in 1921 the demand of Baku has risen to 204,000,000 kw.-hr. in 1925. Plans for the electrification of the main railways in this zone with hydro-electric power from existing stations are well under way. — *Elektrotechnische Zeitschrift*, July 22, 1926.

Electric Equipment of Automobiles. —A. MATTES.—This article gives a general survey of the various electrical accessories which are being used in Europe as more or less standard equipment for modern gasoline cars. It explains the design and the performance of magneto ignition systems, spark plugs, generators for lighting circuits, starting motors, headlamps and horns. The author is well informed on both European and American practice and makes frequent comparisons between the two. Many interesting points are thus brought up. He explains, for example, why European car owners still prefer magneto ignition to the battery system. Of considerable interest are starting motors with automatic gear clutch and combination light and ignition dynamos.—*Elektrotechnische Zeitschrift*, July 8 and 15, 1926.

News of the Industry

Florida Power Plants Weather Tornado

Miami, West Palm Beach and Miami Beach Generators Are Quickly Put Back in Service—Encouraging Reports from All Electric Systems in Storm's Path

DESPITE the tremendous loss to life and property from the tornado which swept south Florida and other Gulf regions last Saturday, Sunday and Monday, the electric light and power systems in the devastated districts appear to have escaped far more lightly than might have been feared. The storm, after bursting in great fury in the district on the southeast coast of Florida lying between Miami and Palm Beach, swept across the state, carrying destruction through a wide band of territory, crossed the Gulf of Mexico in a northwest direction and hit Pensacola, Mobile and neighboring territory in Florida, Alabama and Mississippi. It is impossible so soon to give any detailed account of just how much damage was done to generating plants from floods or hurricane or to how great an extent power transmission lines were put out of service. That, in accordance with the traditional spirit of light and power companies, there was an instant response to the emergency, and that generators were dried out and broken lines repaired in record time wherever this was possible, goes without saying.

The heaviest share of disturbance fell to the lot of the Florida Power & Light Company, which operates plants at Miami, West Palm Beach, Miami Beach and other places in that neighborhood, owns an extensive transmission system now being rapidly extended northward to reach St. Augustine, and is building large stations at Sanford and Fort Lauderdale. The Sanford plant was entirely out of the storm area, and word has reached the American Power & Light Company, the holding company in New York, that the Fort Lauderdale plant suffered no damage except for the wreck of a temporary construction camp. The holding company takes an optimistic view of the entire situation. Though the generating stations at both Miami and West Palm Beach were temporarily put out of commission on Saturday, they were able to resume operation by noon on Sunday. The station built on the causeway at Miami Beach was badly flooded, but the machinery was dried out and put back on the lines on Monday afternoon. While the smaller plants owned by the Florida Power & Light Company in South Florida have not yet reported, it is thought that they escaped with little injury.

Damage to the distribution and transmission systems will be the chief obstacles to the speedy full restoration of service. No details regarding its extent are yet available, but the local company is working 24 hours a day to repair the harm. The company is fortunate in having had four thousand men at work on various projects in Florida. This has provided an ample working force, and word has been received in New York that no more engineers or workmen are required.

Next to the Florida Power & Light Company as potential sufferers from the tornado are the systems operated by the Fitkin interests, with a generating plant at St. Petersburg, and by the Southeastern Power & Light Company, with plants at Pensacola, Mobile and elsewhere.

FITKIN AND SOUTHEASTERN SYSTEMS

The Fitkin utilities in Florida, according to meager reports, through effort of the most strenuous sort got current back quickly on the standing lines and temporary service installed where lines had been completely demolished. The period of total interruption was less than 24 hours. The day following the hurricane 40 per cent service was restored; the second day operation was 70 per cent, and the third day normal conditions obtained.

Besides St. Petersburg, the Fitkin utilities supply electric light and power in Clearwater, Dunnellon, Ocala, Tarpon Springs, Pasadena, Dade City and other towns on the west coast, all directly in the path of the storm.

News from the Southern office of the ELECTRICAL WORLD at Birmingham is to the effect that damage in Mobile was not heavy—in fact, only about one-fourth of that caused by the storm of 1908. Lighting service in the downtown district was not interrupted, though all the power circuits went out. In the outlying sections broken wires and fallen poles caused a suspension of all service. The system is rapidly being brought back to its normal condition, but about ten days will be required to repair all damage.

In Pensacola damage was more serious. One of the guyed steel stacks of the generating station blew down, curtailing the steam capacity, and between 750 and 1,000 transmission poles were overthrown. Discontinuance of service was thus forced. No damage was done to other equipment, and repairs are being made rapidly. It was hoped to start up the generators again some time on Thursday, but it will be two weeks before normal operation is resumed and four weeks before all damage is cleared up. The Southeastern company reports that damage to its system in other Gulf Coast cities, including Pascagoula, Gulfport and Biloxi, is slight.

Tampa, which was on the edge of the storm, escaped lightly, and Stone & Webster, who operate the plant in that city, have been informed that the damage done to the property under their control was inconsequential. A similar report is made by the General Gas & Electric Corporation, whose chief Florida plant—that of the Florida Public Service Company at Orlando—was outside the storm's path.

According to newspaper dispatches, Thomas A. Edison's winter estate at Fort Myers was badly damaged through the destruction of trees and gardens.

Situation as an "Electrical World" Correspondent Views It

From its Tampa correspondent the ELECTRICAL WORLD as it goes to press receives the following dispatch, sent Wednesday night and giving a "close-up" view of the electrical situation in the stricken district. It differs in details to some extent from the news received by the holding companies in New York and by the Southern office of the ELECTRICAL WORLD in Birmingham and may be in error in some of its details, but it is printed for its interest and to give a view of conditions from more than one angle:

"With serious damage to the generating plant of the Florida Power & Light Company at Miami, less serious damage to other power plants, and hundreds of miles of transmission lines throughout the state demanding attention, south Florida is now taking inventory of her electrical losses following the hurricane of Sept. 18. It is yet too early, officials declare, to estimate losses. The Miami plant lost its two brick stacks, one crashing on top of the generating room, and the building is still flooded with water, according to reports. All transmission lines were swept before the wind and many poles went down. Hundreds of workmen are repairing the high lines to bring power into the city, Miami being still in darkness.

"At Miami Beach the generating plant is reported waterlogged, and the same is believed to be true at Hollywood. The plant at West Palm Beach, recently completed, is only slightly damaged. Transmission lines in this area suffered less than further south. The small power plant at Lake Worth closed down for only a few hours Saturday. Between Tampa on the west coast and Palm Beach on the east transmission lines were seriously damaged. The Florida Power & Light Company, the largest service company in the state, has recently built many strong high-tension lines, and these weathered the gale without great damage. Older lines suffered severely.

"At St. Petersburg the Pinellas County Power Company shut off all power Saturday night. Two hundred men succeeded in restoring service to 80 per cent normal by Sunday night. The high-tension line to Clearwater, 23 miles distant, went down, but the small

Clearwater plant was able to take most of the load.

"The electrical storm on Monday following the hurricane struck a substation at Hopewell Mines, and the building burned with $25,000 loss. Nine large transformers were also lost there.

"Generating plants at Bradenton, Fort Myers and Punta Gorda, in the path of the storm on the west coast, were reported only slightly damaged, but power lines and poles were in bad shape. The south-central section of the state reports only wire damage, except for the Moore Haven district, where the small municipal plant was inundated.

"Tampa electrical firms have salesmen in the stricken areas, but with the exception of a request from Miami for transformers, none has yet reported. Several report damage to branch offices in Miami—notably the Pierce Electric Company with an estimate of $18,000 loss. All expect heavy demands for material as the result of widespread damage to lines and transformers."

Charles R. Huntley Dead at 73

President of Buffalo General Electric Company for Many Years—Spectacular Early Career in Pennsylvania Oil Fields—Pioneer of Alternating Current

ANOTHER pioneer in the development of the modern electric central station died on Friday, Sept. 17, when Charles R. Huntley, for a generation president of the Buffalo General Electric Company, succumbed at his home in Lancaster, N. Y., to an attack of arteriosclerosis after an illness of two weeks. Mr. Huntley was widely known as a leader in the electric light and power industry. He was one of the organizers of the National Electric Light Association and served as its president in 1891-92, and he had maintained an influential position among executives of electric utility companies ever since those early days. He was also prominent in general business and industrial circles in upstate New York.

Born at West Winfield, Herkimer County, N. Y., in October, 1853, educated in the schools of Utica, and starting his business career as an assistant in his father's tinsmith shop, Charles Russell Huntley in early life passed through vicissitudes of success and failure. In 1877 he relinquished a bookkeeping post with the Remington Sewing Machine Company at Ilion, N. Y., for one with the American Transfer Company, a Standard Oil Company ally, at Bradford, Pa. This was in the period of the oil boom, and he soon began business for himself as an oil broker, pursuing it with such success that in a few years he accumulated considerable capital. Yielding to the fever for speculation in oil that then prevailed, the money was dissipated in the oil exchange in New York City as quickly as it had been made.

Turns to Electricity

While engaged in the oil business Mr. Huntley became associated with the late Daniel O'Day, then an official of the Standard Oil Company, who was also actively interested in the Brush Electric Company of Buffalo, an enterprise which had been organized in 1881 for the purpose of furnishing street lighting to that city. In 1888 Mr. Huntley joined Mr. O'Day in the conduct of this pioneer business, of which he was soon made general manager. As the electrical art grew the Buffalo undertaking expanded with it, and in 1892 the Buffalo General Electric Company came into being through the consolidation of the Brush company with the Thomson-Houston Company of Buffalo and the United States Electric Light Company, operating in the same territory. Mr. Huntley retained the post of general manager and on the retirement of Mr. O'Day was made president. This office he filled to the day of his death, his 73 years having brought no diminution of

Charles R. Huntley

energy or business acumen, despite the fact that his health was not always of the best. In 1896 he was also made vice-president and general manager of the Cataract Power & Conduit Company, which operated concurrently with the Buffalo General Electric until 1915, when the two organizations were merged. The Cataract company was formed to distribute hydro-electric energy from Niagara Falls, which has since early days been to Buffalo the main source of electrical supply. In the Queen City, indeed, many of the problems connected with the generation and distribution of hydro-electric energy on a large scale were first worked out.

Mr. Huntley's career as a light and power executive was bound up with the great growth of industry in the Buffalo-Niagara district, and to this growth he was a powerful contributor. The Buffalo station when he became connected with it was operating the first alternating-current system to be installed in the United States, Westinghouse alternators having been added to the arc-light dynamos, and his management contributed to the triumph of this innovation, then regarded with doubt by many prominent electrical engineers.

An outstanding instance of Mr. Huntley's aggressive course was the rapid construction of a large steam power house in Buffalo in the early days of the World War. To this six-million-dollar plant, for which ground was broken in January, 1916, and which started, with 60,000 kw. installed, in November of the same year, was attributed the avoidance of industrial depression in that district owing to the diversion of Niagara power to Canada for war-time manufactures. It was built in defiance of timorous counsels from those who thought a large steam station so near the Falls a venturesome and needless enterprise. Another structure for which credit belongs to Mr. Huntley is the fifteen-story tower office building of the Buffalo company, an architectural ornament to the city.

His Wide Interests

When the Buffalo General Electric Company, the Niagara Falls Power Company, the Niagara, Lockport & Ontario Power Company, the Tonawanda Power Company and the Niagara Electric Service Corporation combined in 1925 to form the Buffalo, Niagara & Eastern Power Corporation, Mr. Huntley was made chairman of the board of directors. In addition he was at the time of his death a director of the Niagara Falls Power Company, Niagara, Lockport & Ontario Power Company, Niagara Electric Service Corporation, George Urban Milling Company, Western New York Water Company, Marine Trust Company, People's Bank of Buffalo and General Railway Signal Corporation. He was a director also of the Pan-American Exposition at Buffalo in 1901 and was active in civic affairs, being at one time for three years park commissioner of Buffalo. He was an associate member of the American Institute of Electrical Engineers and belonged to several clubs.

Endowed with a forceful and attractive personality, a friendly disposition characterized by engaging frankness rather than by diplomatic art, keen observation, good judgment, ability to handle men and the power of quick analysis, Mr. Huntley had qualities which in combination marked him as no ordinary man. He enjoyed the loyal support of his subordinates and the confidence and respect of his business associates, and he numbered among his close personal friends some of the most prominent men in the industry. His career in many of its aspects was that of a typical American of the business school. He confessed to having made one mistake—he had cultivated no special hobby outside of his business pursuits. Partly for this reason, perhaps, he was a very hard worker, "toiling," he said, "while most other men were asleep."

Mr. Huntley was married in 1878 to Ida L. Richardson, who with three sons and one daughter survives him. One of his sons, William R. Huntley, is vice-president and general manager of the Buffalo General Electric Company.

Mr. Huntley was buried from his

home in Lancaster on Monday afternoon, Rev. Dr. Charles A. Jessop of St. Paul's Episcopal Church of Buffalo officiating. Interment was in Forest Lawn Cemetery, Buffalo. The bronze coffin was borne on the shoulders of the heads of departments of the Buffalo General Electric Company, and the honorary pallbearers comprised the boards of directors of the several corporations and banks with which Mr. Huntley was connected, his electrical business associates and intimate friends. Among these were Paul Schoellkopf, president of the Niagara Falls Power Company; Fred D. Corey, president of the Niagara, Lockport & Ontario Power Company; J. E. Montague, vice-president and general manager of the Niagara Electric Service Corporation; Le Grand S. De Graff, president of the Tonawanda Power Company; W. E. Robertson and E. D. McCarthy, electrical supply jobbers of Buffalo; Owen D. Young and J. R. Lovejoy of the General Electric Company; M. S. Sloan, Brooklyn Edison Company; W. H. Onken, Jr., editor of the ELECTRICAL WORLD; J. W. Perry, Johns-Manville Company; Dwight P. Robinson, Dwight P. Robinson & Company, New York; H. C. Hopson, Associated Gas & Electric Company; Norman Mack, publisher of the Buffalo *Times*, and Francis X. Schwab, Mayor of Buffalo.

After referring to his long record of loyal, intelligent and efficient service to the People's Bank of Buffalo, of which he was vice-president for 23 years, the directors of that institution in a resolution conclude as follows: "Wise and helpful in counsel, kindly and considerate in his dealings with his fellow men, ever animated by a cheery outlook on life, he established bonds of affectionate friendship which will always remain a grateful memory. He was a pioneer in the field of public utility service and built up an electrical industry which stands second to none measured by its financial success or in the character of the service it has rendered to the community. He was an outstanding citizen of Buffalo, intensely loyal to his home city and giving freely of his time, effort and means to every civic enterprise. We greatly regret his death, and as an affectionate tribute to his worth and an expression of our deep sense of loss be it resolved, that this memorial be spread upon the minutes and that a copy be sent to his bereaved family with our heartfelt sympathy."

Messages of sympathy were received from prominent men in the electrical industry in all sections of the country.

Soviet Power Concession Will Probably Go to America

A sixty-million-dollar concession for hydro-electric development on the Dnieper River in Russia, to serve the Ukraine, has been offered to an American group represented by Hugh L. Cooper, the Soviet government agreeing to make an initial appropriation of $5,000,000 for the purchase of American machinery and equipment. Most of the technical help employed would be American, while the bulk of the ordinary labor would be Russian.

New Englanders Convene at Poland Springs

Commercial Opportunities, Electric Refrigeration, Distribution System Development and Operating Lessons from Edgar Station Conspicuous in Proceedings

MORE than five hundred members and guests of the New England Geographic Division of the National Electric Light Association assembled for the eighteenth annual convention of the division at the Poland Spring House, South Poland, Me., from Monday to Thursday of this week. The program covered a wide range of topics and set a new mark of accomplishment for this, the oldest of the association sections.

On Monday evening William S. Linnell of the Governor's Council welcomed the convention to Maine, emphasizing the importance of maintaining utilities in a condition of prosperity and encouraging pioneer development. In his annual address F. A. Belden, the retiring president, urged granting the commercial man a fair measure of the time and patience hitherto given to the engineer to accomplish worth-while results and made a vigorous plea for standardizing rural-line extension practice and for humanizing the operation of utilities in this period of mergers. National Vice-president H. T. Sands of New York brought the greetings of the parent association and outlined the larger responsibility before industry in public relations and commercial activity. The growing importance of educational work was voiced by E. S. Mansfield of Boston, and President Belden reported excellent progress in the initial field work of the agricultural committee under the direction of W. T. Ackerman.

COMMERCIAL PROBLEMS

Commercial problems occupied two sessions on Tuesday, outstanding features of the program being addresses on merchandising, refrigeration, industrial heating and lighting development. C. Coolidge Tarne of the Curtis Publishing Company spoke on "The Value of National Advertising in Electrical Merchandising"; A. B. Kimball, president Landers, Frary & Clark, advocated merchandising by central stations and adequate financial backing for commercial development, and Earl E. Whitehorne, commercial editor ELECTRICAL WORLD, talked upon the commercial opportunities before the industry and the need of "selling" the complete electric home idea in place of the present piecemeal activities. An exceptionally fine session upon refrigeration followed, with notable introductory addresses by President C. L. Edgar and C. Ernest Greenwood of the Boston Edison company and an inspiring paper upon market outlook by A. H. Goss, president of the Electric Refrigeration Corporation. These will be abstracted in a later issue.

The rapid advance of heavy-duty cooking was reviewed by Grant Call, manager of the commercial heating division of the Edison Electric Appliance Company, Inc., who described the success of more than three hundred New England installations and sketched the economic value and potentialities of the electric cooking load. These installations now exceed 3,328 kw. in connected load and consume about 6,000,000 kw.-hr. yearly, yielding about $200,000 annual revenue. J. D. McManns, Walworth Company, Boston, presented a paper on electric heat treating, and R. B. Brown, Jr., and J. Daniels, Boston, spoke on industrial lighting. W. A. McKay, assistant to the vice-president Westinghouse Lamp Company, New York, told of the remarkable success which has attended the introduction of the simplified-lamp program into the American market.

TECHNICAL SESSION

On Wednesday an interesting technical session was held, in which a vigorous discussion of the network system of low-voltage distribution took place, with papers by D. K. Blake, General Electric Company, and H. Richter, Westinghouse company, on the economic aspects of network development. L. L. Elden, electrical engineer, Boston Edison company, defined the Edison direct-current system within the field of high-density urban loads and urged thorough analysis of every distribution development problem before departing from the radial system of alternating-current supply. The maintenance of voltages corresponding to motor ratings was also strongly advocated.

A feature of the afternoon session was a comprehensive paper by I. E. Moultrop and R. E. Dillon upon operating economies and lessons of high-pressure steam utilization at the Edgar station of the Boston Edison company, showing how various problems have been solved in the use of the 1,200-lb. boiler and turbine installation at this plant. Details will be published in an early issue. It is noteworthy that the use of high-pressure steam in this pioneer installation has not only contributed to record economy of operation, but has been so successful that the company is on the point of ordering additional high-pressure boiler and turbine equipment.

At this session L. L. Elden discussed motor ratings, the use of the service factor and need of improvement in fractional-horsepower motors and urged substituting total temperature measurements for the present temperature-rise method of rating motors.

Well-attended accounting sessions were held on Wednesday and Thursday, and on the latter day a session was for the first time devoted to the women's committee, in which public relations and educational problems were enthusiastically stressed. The convention was scheduled to close Thursday evening with a public relations session. Topical extracts from various papers and addresses will be published in later issues.

Good Commercial Session

Ends Glenwood Springs Meeting of Rocky Mountain Division—Mr. Stone's Views on State Conventions

IN THE course of a noteworthy address at the closing session of the Glenwood Springs (Col.) joint meeting of the Rocky Mountain Division, N.E.L.A., and the Colorado Public Service Association, of which the earlier sessions were reported last week on page 591, G. B. Buck, chairman of the division's Commercial Session, said that for the first time commercial men the country over have a true conception of their responsibility to the industry. The great objective of the Commercial National Section this year is to increase kilowatt-hour sales per capita, and this is almost its sole purpose, he declared. Aside from normal growth, the responsibility for increase in gross earnings rests squarely on the shoulders of commercial men, and since the opportunities for increased business in the commercial and power fields are to some extent limited, it is necessary to look to the home for the real future development of the electrical central-station business.

Miss Isabell Davie spoke of the success of the work of the women's committees all over the country and said that the women of the industry have a still greater mission to perform, which is in the electrification of the home. No one, she said, can so successfully bring this about as the women within the industry.

Officers elected for the ensuing year for the Rocky Mountain Division, N.E.L.A., are: President, W. C. Sterne, president and general manager Summit County Power Company, Denver; first vice-president, C. L. Stannard; second vice-president, E. P. Bacon, and third vice-president, J. A. Clay. The Colorado Public Se[illegible]ociation elected J. F. [illegible]icity manager Mount[illegible]elephone & Telegraph Company, Denver, as president, H. S. Robinson as first vice-president and V. L. Board as second vice-president. O. A. Weller will continue to serve as secretary of both associations.

STATE CONVENTIONS

In the report published last week it was stated that E. F. Stone, president of the Colorado Public Service Association, had recommended that state meetings be abandoned and that efforts be directed toward a greater annual convention. This was inaccurate. Mr. Stone recommended that meetings of the state associations of Colorado, Wyoming and New Mexico be rearranged to permit a greater and fully co-operative joint annual convention. He suggested that each state association hold one purely local convention each year to transact business of local character only, recommending further that the Rocky Mountain Division limit its convention activities to the one annual joint convention at Glenwood Springs and that such convention be fully and officially participated in by each state association. This plan, Mr. Stone believes, would result in greater and far more beneficial co-operation between state associations, greater and more representative attendance at the joint convention and the accomplishment of a greater amount and a higher quality of work in the three states involved, jointly and severally.

Stanford University's Experimental Generators Tested

Successful testing of the six laboratory transformers built for Leland Stanford University at Palo Alto, Cal., and rated at 2,100,000 volts, is reported. The tests, made this week under the supervision of Prof. Harris J. Ryan, marked the opening of the laboratory, where scientists gathered to witness the electrical display, in which an arc of varicolored flame shot across a 20-ft. gap between two electrode plates. After making three tests the plates were replaced with electrode points, and an even more spectacular demonstration resulted. The corona was more pronounced, and when the arc was created a loud explosion followed.

Each unit is rated at 350,000 volts high-tension, 2,300 volts low-tension, and weighs 22 tons. They have been so designed and constructed that they may be used in every manner of connection for the whole range of voltage, single-phase or three-phase, up to 2,100,000 volts single-phase, 1,200,000 volts three-phase, and lesser voltages.

The principal use of these transformers will be to discover methods of transmitting exceptionally high voltage and to lessen if not entirely eliminate existing losses in power transmission. A large tract which is part of the laboratory property will be used in the experiments, including the study of the nature of lightning and other electrical phenomena.

The laboratory was built for Professor Ryan by Stanford University, with the financial aid of power companies. Two years was required to assemble the equipment, including the transformers, which, made at the Pittsfield works of the General Electric Company, are the largest ever constructed.

Virginian Railway Electrification Completed

The completion of the fifteen-million-dollar electrification program of the Virginian Railway and the inauguration of 132 miles of electrical service from Roanoke to Elmore, W. Va., was announced on Monday of this week. Electric service over the line between Elmore and Princeton was begun in September, 1925. The completion of the last lap between Princeton and Roanoke was marked by the transportation of a train of 9,040 tons, which was pulled into Roanoke by one of the Virginian's three-unit electric locomotives.

Electric Freight Engine Pulls 108 Cars 32 Miles an Hour

A two-unit electric freight engine built by the American Locomotive Company and equipped by the General Electric Company was tested on New York Central Railroad electrified tracks last Sunday between Harmon and New York City and pulled a 108-car train, stretching nearly a mile, at a maximum speed of more than 32 miles an hour, without heating or encountering other difficulties which have impeded the use of electric engines for heavy duty. The total distance covered in three round trips was 144 miles. As a result, the New York Central will add several similar engines to its equpiment for use over the electrified parts of its line. A steam engine previously attached to the train attained only 5 miles an hour.

The locomotive is 68 ft. long, stands 14 ft. high from the track to overhead and weighs 170 tons, distributed on each of the eight axles. The wheels, 42 in. in diameter, are all drivers. Eight motors, one mounted on each axle, create a total of 3,200 hp. on the standard one-hour basis. The two units are joined in such a manner as to allow the locomotive to flex in the middle when going around sharp curves. Each unit consists of a cab and two four-wheel trucks, so arranged that controls in both ends allow it to be run in either direction without turning. Safe running speed is put at 60 miles an hour.

Railway Electrification Papers at Basle

A leading subject discussed at the sectional meeting of the World Power Conference recently held at Basle, Switzerland, in addition to those already noticed in these columns, was railway electrification, on which reports were presented from most European countries, the United States and Japan.

William S. Murray, consulting engineer of New York, who represented this country, took a broad view of the situation. His main contention was that the use of electrical energy for railway operation has fallen far behind the use made of it for other purposes. The revolution of the transportation system has not kept pace with industrial production. About 80 per cent of the electrical energy produced in America is absorbed by industry, the railway demand being exceedingly small in comparison. The need of the times, Mr. Murray insisted, is the acceptance of a standard type of power for railroads in place of the variety of systems now existing. What has been done hitherto is a mere experiment, as upon the electrified lines of the United States only 5 per cent of the total traffic tonnage is carried. Two opinions expressed in the paper were that in future the standard system of railway operation should be high-voltage direct current and that the railroad companies should procure power from public sources.

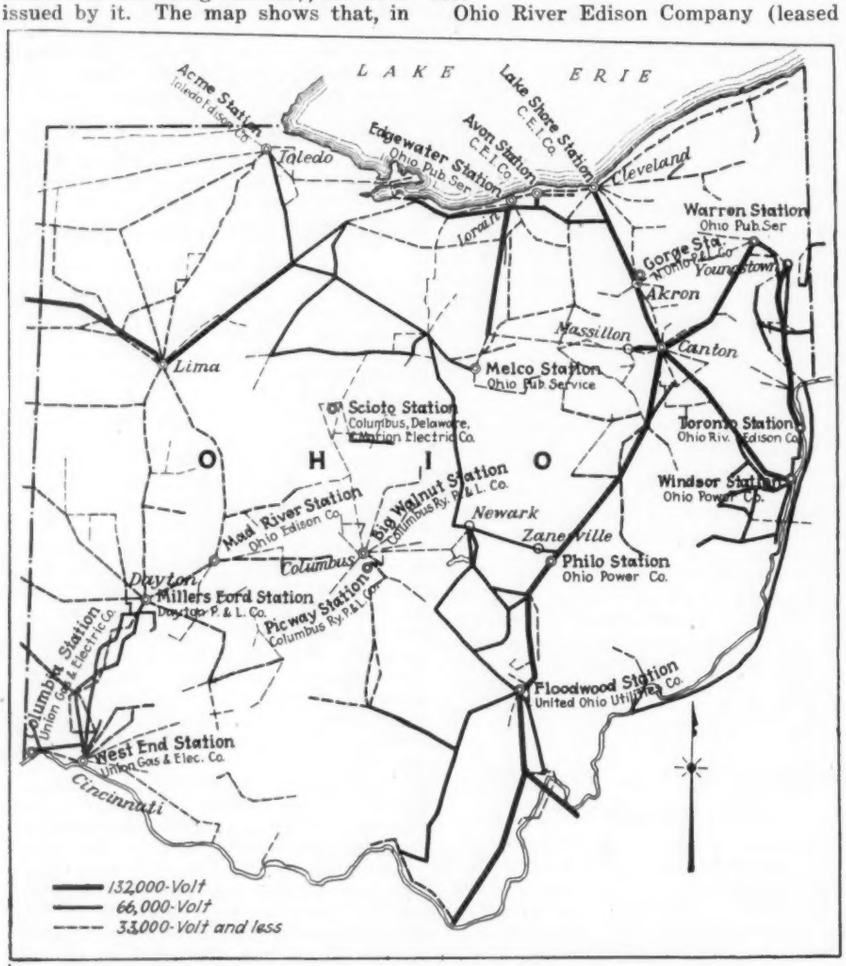
Colonel E. O'Brien, the reporter for Great Britain, dealt with the broad economic aspects of railway electrification. His report stated that even in countries where coal was cheap electrification could effect economies in cost of locomotive operation and maintenance of from 10 to 25 per cent and that a 50 per cent increase of speed could be effected without proportionate increase in cost. Other economic advantages referred to were reduction in cost of track and depot maintenance, generally improved conditions of operation and supplies of cheap energy for light and power. An important problem which has not yet been solved in England, Colonel O'Brien said, is

whether the electric locomotive requires one or two men to operate it, and he thought that if this question could be satisfactorily settled railway electrification would receive a great stimulus.

Other reports described some existing installations, including those on the French, Dutch, German, Swiss and Swedish railways. The report on the electrification of the Stockholm-Gothenburg section of the Swedish State Railways was particularly interesting.

Ohio Power Map Is Brought Up to Date

SO RAPID has been electrical development in Ohio that a map of the power plants and interconnected systems in that state issued a year ago by the Ohio Committee of Public Utility Information is already out of date, and a new map, of which the one shown here is a simplified reproduction (the smaller details being omitted), has been issued by it. The map shows that, in addition to 5,000 miles of lines of 11,000 volts and more, there are in the state several thousand miles of transmission lines of less voltage. These lines cover the state, connecting Lake Erie with the Ohio River and Ohio electric systems with those of the five bordering states.



LARGE GENERATING STATIONS AND INTERCONNECTED SYSTEMS IN OHIO

The newest plant to be opened in Ohio this year is the Avon station, on Lake Erie, 20 miles west of Cleveland, while the Columbia station, on the Ohio River, 20 miles west of Cincinnati, was opened not many months ago. The Big Walnut plant, at Columbus, and Philo station, on the Muskingum River, near Zanesville, have been opened during the past year. The Mad River plant, near Springfield, and Picway station, on the Scioto River, 15 miles south of Columbus, are being rushed to completion. With these, Ohio will boast of nineteen superpower plants. These plants are:

Cleveland Electric Illuminating Company.—Avon, Lake Shore, Canal Road.

Union Gas & Electric Company.—Columbia, West End.

Ohio Power Company, Philo, Windsor.

Ohio River Edison Company (leased to Pennsylvania-Ohio Electric Company).—Toronto.

Toledo Edison Company.—Acme.

Ohio Public Service Company. — Melco, Warren, Edgewater.

Dayton Power & Light Company.—Miller's Ford.

Columbus Railway, Power & Light Company.—Big Walnut, Picway.

United Ohio Utilities Company.—Floodwood.

Northern Ohio Power & Light Company.—Gorge.

Columbus, Delaware & Marion Electric Company.—Scioto.

Ohio Edison Company.—Mad River.

The electrical industry in this state serves more than 1,100,000 customers and has invested $413,000,000.

Purchases and Mergers

Georgia Power Company Is Formed—West Virginia Water & Electric and Kewanee Utilities Sold

FOLLOWING the filing of a petition for a charter for the Georgia Power Company, it was announced by P. S. Arkwright, president of the Georgia Railway & Power Company, that the purpose of the new company is to consolidate the various electric light and power, street-railway and gas companies in Georgia of which the stock has been acquired by the Southeastern Power & Light Company. These properties include the Georgia Railway & Power Company, Georgia Railway & Electric Company, Athens Railway & Electric Company, Rome Railway & Electric Company, Georgia Utilities Company, Georgia Southern Power Company, Milledgeville Lighting Company, Macon Railway & Electric Company and the Central Georgia Power Company. Their consolidation will aid in financing the enterprise and result in a unification of the various operations. Mr. Arkwright will be president of the new company and H. M. Atkinson chairman of the board of directors.

Conclusion of an agreement between the Federal Water Service Corporation and the American Gas & Electric Company for the purchase of the West Virginia Water & Electric Company from the second-named concern is announced. The West Virginia utility, with offices in Charleston, provides electric service in that city, Kanawha City, Malden and Vandalia, West Va. It also controls and operates the Dunbar Light & Power Company and the St. Albans Electric Power & Light Company. Payment will be by debentures in the amount of $5,000,000,

Purchase by the Illinois Power & Light Corporation of the holdings of B. F. Lyons in the Kewanee (Ill.) public utility enterprises is announced. Under the name of the Kewanee Public Service Company the electric light and power, street railway and gas utilities of Kewanee, including the former municipal plant, were united two years ago and a franchise was granted to Mr. Lyons. The Illinois Power & Light will make Kewanee a point in its interconnected system and it will be reached by the transmission lines now extending from Keokuk to Galva, thus giving Kewanee four sources of power.

A petition has been filed with the New York Public Service Commission by the Upper Hudson Electric & Railroad Company of Catskill requesting authority to purchase the electric plant of the Westerlo Electric Service, at Westerlo, N. Y., and to merge the latter with itself.

The Central Iowa Power & Light Company of Fort Dodge, Iowa, has acquired the Palmer (Iowa) and Varina (Iowa) lighting plants for $13,000 and $11,000 respectively. The Central company also expects to acquire the Burt system.

The Southern Michigan Light & Power Company has bought the Ravenna-Conklin-Marne Power Company, which serves these villages and also Eastmanville. The Southern Michigan company is controlled by the Common-

wealth Power Corporation and is allied with the Consumers Power Company.

The Nebraska Electric Power Company of Lexington, Neb., has purchased the municipal plant at Gordon, Neb., for $73,500.

The plant owned and operated by A. H. Jones at Senoia, Ga., has been purchased by the Georgia Railway & Power Company.

Without a dissenting vote the citizens of Glasgow, Mont., have decided to sell their municipal power plant and permit the Montana Power Company to build an extension to Glasgow from Malta.

It is reported from Canada that plans are being formulated by the Loewenstein group in Brussels for consolidation of all the old Mackenzie Latin and Latin-American enterprises, including the Brazilian Traction, Light & Power Company, Barcelona Traction, Light & Power Company, Mexican Light & Power, Mexico Tramways and Mexican Northwestern Railway. The holding company being utilized for this attempt is the Société International Hydro-Electrique, better known as the Belgian Hydro. This company already controls the Barcelona company and has a heavy interest in the Mexican Light & Power Company and the Mexico Tramways Company.

West Tells Why State Could Not Develop Conowingo

Speaking at the banquet of the Maryland Utilities Association, which met at Salisbury, Md., last Saturday, Harold E. West, chairman of the Maryland Public Service Commission, went at considerable length into the reasons why the Conowingo hydro-electric development could not have been undertaken by the state, as public ownership advocates in Maryland maintain that it might have been. Constitutional obstacles, the interstate character of the undertaking, the fact that the market for the power is in Pennsylvania and the great expenditure involved put such an idea out of the question, he held, quite apart from theoretical views for or against state ownership of water-power systems.

At the morning session of the association the discussions centered on utility problems connected with electricity, gas, water and transportation, the electric group meeting under the chairmanship of G. P. Mangan, sales manager of the Potomac Electric Power Company of Washington. The afternoon session was given over to addresses by Dr. E. J. Cattell, city statistician of Philadelphia, and A. Bliss McCrum, secretary of the Public Utilities Association of West Virginia. In addition to Mr. West, Harvey J. Hill, director-general of the Del-Mar-Va Eastern Shore Association, and Henry Holzapfel, Jr., vice-president of the Potomac Edison Company, spoke at the banquet, over which Fred P. Atkins presided.

Officers of the Maryland association are: President, R. Paul Smith, Hagerstown; vice-president, H. B. Potter, Baltimore; treasurer, H. T. Connolly, Baltimore; secretary, H. L. Shindledecker. The next meeting will be held in February in Baltimore.

Briefer News

Voters to Pass on Proposed County Plant Near Cordele, Ga.—Plans have been completed at Cordele, Ga., for a bond election to provide $1,250,000 for the completion of a county hydro-electric dam and power plant on the Flint River. The project will be put before the electors in November. Tentative engineering plans for the dam and power plant are ready.

Nashville's New Generator Goes on the Line.—The new 20,000-kw. Westinghouse turbo-generator of the Nashville (Tenn.) Railway & Light Company went into permanent service last week, bringing the total capacity of the Nashville company up to 48,000 kw. With this new equipment Nashville will be able to help out nearby hydro-electric plants in times of drought and even to send power to Chattanooga should an emergency arise.

Genoa, Italy, Has New Steam Station Almost Ready.—A new steam-electric central station rated at 100,000 kw. and said to be the largest in Italy is to go into service in Genoa in a few weeks. It will be linked up with hydro-electric developments and other steam stations to supply electric power to the entire north Italian industrial zone. The station belongs to the Società Generale Italiana Edison di Elettricità. Its stokers are American-made and will burn either American or British coal.

Underground Systems Reference Book Under Consideration.—A prospectus of a proposed underground systems reference book, similar in a general way to the "Handbook for Electrical Metermen" and the "Relay Handbook," has been prepared by the underground systems committee of the N.E.L.A., and that association is now carrying on a questionnaire to enable it to decide whether the publication of such a work by the association is desirable. The book, if it is decided to proceed with it, will be several years in preparation.

New Plant in Prospect for East Kootenay (B. C.) Power & Light Company.—Industrial development in the Kootenay district of British Columbia has led the East Kootenay Power & Light Company of Fernie to determine upon the erection of a steam plant at Crow's Nest Lake. The company has hydro plants at Bull River and Elko Falls, rated at 22,000 hp., and 40,000 hp. more is said to be available.

Nine Years Required for Engineer's Degree.—Nine years will hereafter be the minimum time in which the degree of "engineer" may be won from Lehigh University, says an official statement just issued by President Charles R. Richards. Beginning with the entering class next fall, the usual four-year course will lead to the degree of bachelor of science in the various branches of engineering. Five years of acceptable practical experience in responsible charge of work after graduation and the submission of a suitable thesis will be required before the university will stamp a candidate as a full-fledged civil, mechanical, electrical or chemical engineer. Coincident with this change will come a revision of the courses of study by which greater emphasis will be placed on the fundamentals of engineering, mathematics, physics and chemistry and less emphasis on the specialized details of engineering practice.

Two More Trans-Mississippi Lines.—Two 13,200-volt transmission lines are to be strung across the Mississippi River this fall in the vicinity of the Tri-Cities. They will extend from the new Riverside plant at Bettendorf, near Davenport, Iowa, to Tenth Street and Third Avenue, East Moline, Ill., where a distribution plant is to be built by the United Light & Power Company at a cost of $200,000. The lines will be supported by high steel towers on each side of the river.

New Home for Insull Interests to Be Built in Maine.—Work will begin soon upon an office building for the New England Public Service Company and Central Maine Power Company at Augusta, Me., the construction being under the direction of the Morton C. Tuttle Company, Boston, builder of the Gulf Island hydro-electric development near Lewiston for these interests. The new structure will be at Green and Bradbury Streets, overlooking the business center of the city, and will be of concrete and brick, 175 ft. long, 42 ft. wide and with three stories and a basement. Estimated cost is $175,000.

Comparative Size of Gatineau Development.—The record of the Gatineau Power Company, the International Paper Company subsidiary which is about to construct a hydro-electric plant on the Gatineau River with an initial installation of about 380,000 hp., is believed to be unique in the annals of power corporations in that between 85 per cent and 90 per cent of its output is already contracted for. As previously reported, between 230,000 hp. and 260,000 hp. will be sold to the Hydro-Electric Power Commission of Ontario, the price being $15 per horsepower per year. The Gatineau plant will be somewhat larger than the initial 300,000-hp. plant at Conowingo and will also exceed the Muscle Shoals plant in size. The only hydro-electric installations in the East which excel it are those on both sides of Niagara Falls and the Duke-Price developments on the Saguenay River in Quebec. Its magnitude is shown by the fact that a trust deed, mortgage and pledge to the Royal Trust Company of Montreal for the amount of $250,000,000 has been registered.

Stator on Way to California Plant Falls Down Canyon.—A 35-ton stator intended for the generator of the Balch power house of the San Joaquin Light & Power Corporation on the Kings River, while being hauled over the Kings River Road recently, broke down the outer edge of a narrow piece of roadbed and, tipping over, rolled into the bed of the river more than 100 ft. below. In falling the stator carried

with it the 50-ton trailer on which it rested, a 75-hp. caterpillar and a 5-ton truck which had been used to help the tractor in pulling the heavy load up the grades. All the crew jumped clear except one brakeman, who was hurled 30 ft. and seriously hurt. Examination by engineers developed the fact that the windings on the stator must be replaced, which may require two months' time. This will not delay completion of the Balch power house, however.

Chicago Launches "Red Seal" Campaign.—Contractors, jobbers, manufacturers and utility representatives gathered at a banquet held under the auspices of the Electric Association at the Electric Club, Chicago, on Sept. 13 to hear W. L. Goodwin of the Society for Electrical Development explain the "red seal" plan. About 170 men were present. The final specifications and copies of newspaper advertising were distributed and complete operating details explained. Mr. Goodwin announced that a red seal license to the Electric Association had been granted. R. Bourke Corcoran, manager of the association, explained the local red seal specifications, which make no drastic changes in the commonly accepted specifications for smaller places. Chicago is the largest city yet to receive the license.

McGregor (Col.) Plant Being Pushed to Completion.—The Colorado Public Utilities Corporation is making rapid strides in the erection of a structure to house its new steam generating plant at McGregor, Col. Progress is also being made in the construction of transmission lines from McGregor toward Hayden, Craig and the oil wells of the Moffat fields. This company recently took over the electric light systems in Steamboat Springs, Oak Creek, Hayden and Craig. It is expected that by fall the plant will be able to supply these towns and likewise the mines in Routt and Moffat Counties. The first unit to be installed will have a capacity of 2,700 kw., and it is estimated that the initial cost of buildings and electrical equipment at the central plant will exceed $200,000. Ample provision is being made for additional units as development of the territory requires.

Virginia Electric & Power's New Lines.—Construction of the transmission lines by which the Virginia Electric & Power Company will serve Elizabeth City, Edenton and Hertford, N. C., is well under way, Superintendent R. J. Throckmorton announces, and the line through which Smithfield, Va., will be served will be completed this month. The right-of-way for the line from Suffolk to the three North Carolina cities, which passes through the fringe of the Dismal Swamp, has been cleared, Mr. Throckmorton says, and construction gangs are erecting poles. There is 65 miles of line to be erected, 37 miles from Suffolk to Windfall, where the line branches; 18 miles from Windfall to Elizabeth City, and 13 miles from Windfall to Edenton and Hertford. The Suffolk-Windfall line will carry 110,000 volts and the branches 33,000. Smithfield will be served by an extension of the 11,000-volt line constructed last year from Suffolk to Chuckatuck, at the mouth of the Nansemond River. The company purchased the Smithfield local plant some time ago and is operating it pending the completion of its line.

Rates Reduced on Yakima-Walla Walla System. — Effecting a saving estimated at $150,000 annually to its customers on the Yakima-Walla Walla system in the State of Washington, the Pacific Power & Light Company, Portland, has reduced rates on nearly all lighting and power schedules. New tariffs have been filed reducing residential lighting, combined residential lighting and cooking, commercial lighting and general power schedules in all towns served by the company to rates comparable with those of towns served by other companies in the surrounding territory. The reduction was voluntary and was made possible by increased business and improvements in operating methods.

Coming Meetings of Electrical and Allied Societies

[A complete directory of electrical associations, with their secretaries, is published in the first issue of each volume. For latest list see ELECTRICAL WORLD, July 3, page 50.]

Wisconsin Chapter, Western Section International Association of Electrical Inspectors—Milwaukee, Sept. 27 and 28. Harvey Griem, City Hall, West Allis, Wis.

Association of Edison Illuminating Companies — Chateau Frontenac, Quebec, Sept. 27-Oct. 1. P. S. Millar, 80th St. and East End Ave., New York.

American Society of Mechanical Engineers—Richmond, Va., Sept. 27-Oct. 1. C. W. Rice, 29 West 39th St., New York.

Public Utilities Association of West Virginia—Charleston, W. Va., Oct. 1 and 2. A. Bliss McCrum, 514 Charleston National Bank Bldg., Charleston.

Empire State Gas and Electric Association—Lake Placid Club, N. Y., Oct. 4 and 5. C. H. B. Chapin, Grand Central Terminal, New York.

Pennsylvania State Association of Electrical Contractors and Dealers—Elks' Club, Philadelphia, Oct. 4-6. M. G. Sellers, 1202 Locust St., Philadelphia.

American Electric Railway Association —Cleveland, Oct. 4-8. J. W. Welsh, 292 Madison Ave., New York.

American Electrochemical Society — Hotel Washington, Washington, Oct. 7-9. C. G. Fink, Columbia University, New York.

North Atlantic Section, American Society of Agricultural Engineers—State College, Pa., Oct. 11-13. R. T. Wagner, 1 River Road, Schenectady.

Kansas Section, N. E. L. A.—Manhattan, Kan., Oct. 14-16. H. Lee Jones, 401 National Reserve Bldg., Topeka, Kan.

Electrical Supply Jobbers' Association — Atlantic City, Oct. 18-22. F. Overbagh, 411 South Clinton St., Chicago.

Electric Power Club—Briarcliff Lodge, Briarcliff Manor, N. Y., Oct. 25-28. S. N. Clarkson, B. F. Keith Bldg., Cleveland.

National Safety Council — Detroit, Mich., Oct. 25-29. W. H. Cameron, 168 N. Michigan Ave., Chicago.

National Association of Railroad and Utilities Commissioners—Asheville, N. C., Nov. 9-12. J. B. Walker, 270 Madison Ave., New York.

American Institute of Electrical Engineers — Regional meeting, New York, Nov. 11-12. F. L. Hutchinson, 33 West 39th Street, New York.

American Welding Society — Buffalo, Nov. 16-19. M. M. Kelly, 29 West 39th Street, New York.

Winnipeg Power Agreement Attacked.—An attempt is being made to block the power agreement entered into between the city of Winnipeg, Manitoba, and the Manitoba Power Company, which was noted last week (page 596). The courts will be asked to quash the bylaw authorizing the purchase of power by the city from the company, involving the expenditure of $4,375,000, on the ground that it is illegal and without the indorsation of the ratepayers. The agreement between the power company and the city was ratified Sept. 12, providing for the purchase of power for a period of between nine and eleven years, commencing next September. Labors leaders demanded a referendum.

One Thousand Kansans to Visit Electrified Farms.—Preparations are under way for the accommodation of a thousand or more Kansans who are expected to participate in a field-day tour of seven electrified farms near Larned on Sept. 29. Progress made and results obtained by these experimental projects, which have now been in operation ten months, are to be reviewed. Coincident with the field-day tour, the semi-annual meeting of the Kansas Committee on the Relation of Electricity to Agriculture will be held, it is announced by Prof. H. B. Walker of the State Agricultural College, who is secretary and state supervisor of the committee. The field work at Larned has been under the supervision of H. S. Hinrichs of the engineering department of the college. Among the organizations from which delegations will be sent for the field-day tour are the State Farm Bureau, Farmers' Union, State Grange, State Board of Agriculture, University of Kansas, Kansas State Agricultural College, State Irrigation Department and the Kansas Section of the National Electric Light Association.

Texas Company to Add a Hundred Miles of Transmission to Its System.—An addition of more than a hundred miles of power transmission lines to its system in south Texas is to be made by the Central Power & Light Company, according to E. B. Neiswanger, vice-president and general manager. The projects include a line from Nordheim to Kenedy, one from Eagle Lake to Columbus and Schulenburg, and one from Gonzales to Luling. All this work is to be hurried, but the Kenedy connection will come first, with promise of completion by Nov. 15. Engineers are surveying for lines between Crystal City, Catarina and Cotulla, and from Catarina to Laredo. It is the company's program to add during the next year several hundred miles of transmission lines to its south Texas connections, all of them to be linked up by means of the interconnections at Saspamco and Spanish Pass, the intervening line belonging to the San Antonio Public Service Company. Interconnected lines now run in an unbroken system into Oklahoma almost as far as the Kansas line. The Central Power & Light Company, Mr. Neiswanger said, will continue for some time to come to spend $750,000 every month in extensions and betterments. It will expend more than $1,000,000 in Corpus Christi and the immediate section.

Men of the Industry

F. C. Hanker Made Manager of Central-Station Engineering

Reorganization of the general engineering department of the Westinghouse Electric & Manufacturing Company has been announced by H. W. Cope, assistant director of engineering. The reorganization has necessitated the reallocation of several engineers, four being elevated to managers of engineering. These are F. C. Hanker, manager of central-station engineering; S. B. Cooper, manager of railway engineering; G. E. Stoltz, manager of industrial engineering, and W. E. Thau, manager of marine engineering. Mr. Hanker, the new manager of central-station engineering, is a native of Toledo, Ill., and a graduate of Purdue University in electrical engineering. He is a member of the American Institute of Electrical Engineers and of the Engineers' Club of New York. Other appointments announced by Mr. Cope in the field of central-station engineering included the following as engineers in their respective fields: **C. A. Powel,** generating-station engineering; **R. D. Evans,** transmission engineering, and **C. A. Butcher,** substation engineering. In the field of industrial engineering **E. B. Dawson** was appointed engineer in electrochemical and electrometallurgical work.

Owen D. Young, chairman of the board of the General Electric Company, who is president of the trustees of St. Lawrence University, Canton, N. Y., and a member of the class of 1894, has given to the university an outdoor theater on the campus to be used for commencement exercises, theatricals and pageants. The theater is to be called the Cammie Pendleton Gaines Theater in recognition of the active interest taken by Mrs. Charles K. Gaines, class of 1878, in all dramatic enterprises at the university. The theater is being constructed by M. G. Merritt, landscape architect, of Rome, N. Y., under whose direction the campus and the lands east of the campus, recently bought by Mr. Young, are being developed.

John W. Lieb, vice-president of the New York Edison Company, accompanied by Mrs. Lieb, is now making an extensive European trip, having sailed on the *Homeric* on July 24. Recently Mr. and Mrs. Lieb with a large party of prominent Italian industrial leaders, former colleagues and friends of Mr. Lieb's, motored from Milan to Villa d'Este, Lake Como, where a banquet was tendered the American visitors. On his arrival in London Mr. Lieb attended the Oxford meeting of the British Association for the Advancement of Science, which was in session from Aug. 4 to Aug. 11. He has been visiting industrial museums in Europe, and to the Deutsche Museum in Munich he presented a model of the old Pearl Street station in New York City. He attended the section meeting of the World Power Conference at Basle, Switzerland, which was in session from Aug. 31 to Sept. 12, presiding at the session on Sept. 6, when the subject under discussion was the relation between electrical energy produced thermally and energy produced hydraulically.

P. H. Chase New President of Pennsylvania Association

Philip H. Chase, who was elected president of the Pennsylvania Electric Association at the recent meeting in Bedford Springs, as announced in the Sept. 18 issue of the ELECTRICAL WORLD, has been affiliated with the

P. H. CHASE

Philadelphia Electric Company since 1921 as assistant engineer, supervising design, construction and operation of the transmission and distribution systems. A native of Hanover, N. H., and a graduate of Dartmouth College, Mr. Chase received the B. S. degree in electrical engineering from the Massachusetts Institute of Technology in 1909 and the degree of master of electrical engineering from Harvard University in 1910.

Following the completion of his technical education, he entered the employ of the Public Service Electric Company of New Jersey, Newark, where he remained seven years, as assistant to the superintendent of distribution, supervising distribution and substation operation, and subsequently as assistant engineer on electrical station and substation design and construction. In 1917 he joined the American Railways Company of Philadelphia as chief electrical engineer in general charge of electrical work on the various properties of this holding company, now the American Electric Power Company. His next connection was with the Philadelphia Electric Company in 1921.

Mr. Chase has long been prominent in the activities of the Pennsylvania Electric Association, having been chairman of the overhead systems committee, chairman of the Technical Section, treasurer and first vice-president. He has also done extensive committee work in the American Institute of Electrical Engineers, the Illuminating Engineering Society and the National Electric Light Association. Mr. Chase is the author of numerous articles contributed to the technical press and of reports presented before engineering bodies. He also holds several patents on cable, distribution systems and other engineering devices.

E. N. Hurley, Jr., well known in the electrical trades through his previous long connection with the Thor Washing Machine Company and as an organizer and executive of young industries, has recently been elected to the presidency of the Walbert Manufacturing Company, makers of "Isofarad" radio sets, the "Pentrola" and other recent radio developments. About six months ago Mr. Hurley became interested in this company, and he has since been engaged in extending channels of distribution, acquiring a new plant and in reorganization of the various departments of the company.

S. G. Gassaway, for the past three years assistant manager of the commercial department of the Oklahoma Gas & Electric Company, has been appointed general manager of the Petroleum Rectifying Company of California, with offices in Los Angeles. A graduate of the University of California in electrical, mechanical and hydraulic engineering, Mr. Gassaway has long been considered one of the leading electric power engineers of the Southwest. He is an authority on the application of electricity to the petroleum industry, being the author of many technical articles and papers on this subject.

Obituary

Dr. George I. Alden, one of the most distinguished mechanical engineers in New England, a founder of the Norton Company of Worcester, Mass., and for 28 years professor of mechanical engineering at the Worcester Polytechnic Institute, died Sept. 13 at Princeton, Mass. Dr. Alden was born at Templeton, Mass., 83 years ago. He was a graduate of the Lawrence Scientific School of Harvard University and twice served as acting president of the Worcester institute. He was chairman of the board of the Norton Company at the time of his death and was the inventor of the Alden absorption dynamometer and an able writer upon engineering topics.

Robert Jemison, financial and industrial leader of Birmingham, Ala., and formerly president of the Birmingham Railway, Light & Power Company, died Sept. 16, following a heart attack. Mr. Jemison had been identified with the electrical interests in Birmingham for 20 years when he retired from the presidency of the Birmingham Railway, Light & Power Company to become chairman of the executive board in 1907. From that date until his death he had spent most of his time in travel and philanthropic work. Mr. Jemison was born in Tuscaloosa 73 years ago and was a graduate of the University of Alabama.

William Seward Smith, a member of the electrical firm of Nichols & Smith of Brockport and Le Roy, N. Y., died suddenly at his home in Brockport on Sept. 16.

Financial and Corporate

Keener Market Demand

Some Substantial Gains Recorded and New High Points Reached—Bond Market Is Steady

AGAIN the preferred stocks have been the center of interest in the public utility securities markets during the past week, though even here there is a dearth of activity in comparison with the situation a year ago. Some issues have been decidedly firm during the past few days, notably Memphis Power & Light preferred, which has been firm at 108½. Keen demand existed also for such stocks as Alabama Power, Birmingham Electric, New Orleans Public Service, Nebraska Power, Southwestern Power & Light and Ohio Edison.

Among the common stocks American Gas & Electric was outstanding, having established a new high record for all time. A quotation of 107⅛ was reached against 103 a week ago. The previous high for the year was 106¼ and the low 64. The general trend of the common stocks has been fairly even, although some companies have shown unexpectedly favorable earnings statements. Gross revenue of the Detroit Edison Company and subsidiaries for August was $3,363,496 against $2,869,417 for August a year ago. Net income after all charges was $514,278 against $395,231. Net earnings of Alabama Power, chief subsidiary of Southeastern Power & Light, for the twelve months ended August were $6,047,607 against $4,995,515 after operating expenses and taxes. Stocks of operating companies generally have made a better recovery from the low point of a few months ago than those of the holding companies. Some of them have exceeded previous high records. The general recovery is from 50 to 70 per cent.

Buying in the bond market has been fairly active and a few gains have been made, due partly, perhaps, to predictions of a higher bond market. Long Island Lighting 5's and Northern States Power first 5's made slight gains during the week. The effect of higher money rates may become a factor in the situation. The present basis of 4½ to 5 per cent places the bonds at approximately the pre-war level. Whether or not a low point has been reached depends on a variety of factors. There are those who feel that it has.

New Capital Issues

During the week ended Sept. 23 the Tide Water Power Company made an offering of first lien and refunding mortgage gold bonds, series C, amounting to $3,750,000, the price being 98¾ and interest to yield about 5.45 per cent. The company furnishes without competition electric light and power in Wilmington, N. C., and vicinity and, through its subsidiaries, electric light and power will be served to a territory in Florida extending from St. Petersburg northward to the Georgia state line. These bonds, dated Aug. 2, 1926, and maturing Aug. 1, 1929, are secured by a direct first mortgage on the property in Wilmington and vicinity, subject as to part of it to a closed mortgage having $295,250 bonds outstanding with the public. They are further secured by the direct pledge of all the first mortgage bonds and all the common stock (except directors' qualifying shares) of the Pinellas County Power Company. Proceeds of the sale of these bonds together with proceeds from other issues will be used for the acquisition of all of the physical property of the Florida Power Corporation and the entire capital stock of the West Florida Power Company, to provide funds for the redemption of the company's 7 per cent debenture bonds totaling $1,461,900, and in part for expenditures already made and additional expenditures to be made in connection with a construction program involving a total of $6,000,000.

A one-million-dollar issue was offered by the Broad River Power Company in the form of first and refunding mortgage 5 per cent gold bonds, series A, at 93½ and interest, yielding over 5.45 per cent. These bonds are secured by a mortgage constituting a first lien on the new steam generating station at Parr Shoals, on approximately 70 miles of double-circuit steel-tower 110,000-volt transmission lines and on other important property and on all additions, extensions, plants and systems hereafter acquired not subject to lien at the time of such acquisition.

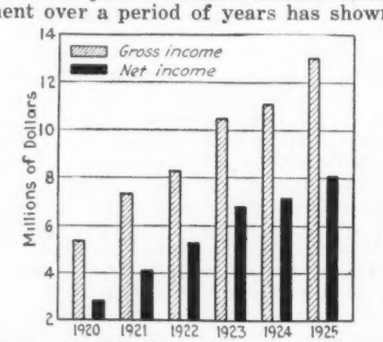
The Northern New York Utilities, Inc., made an offering of an additional issue of first lien and refunding 5 per cent gold bonds, series "E," priced at 99 and accrued interest to yield over 5 per cent. These bonds were dated July 1, 1925, and mature July 1, 1955.

Philadelphia Electric Earnings Increase

Greater Volume of Business Leads to Larger Operating Expenses but Makes Possible a 12 per Cent Rise in Net Earnings for 1925

AN 11 per cent rise in gross earnings and a 12 per cent increase in net for 1925 show that the Philadelphia Electric Company's business is enjoying a period of healthy growth. That the year's operations would show increased operating costs was to be expected. That this rise was less than 7 per cent against the 12 per cent rise in net shows that the new business acquired was profitable.

Philadelphia Electric's income statement over a period of years has shown a steady growth. Gross revenue has more than doubled since 1919 to the present figure of $33,203,768, and net income has more than tripled in the same period. Last year operating expenses took $20,522,903, leaving a gross income of $13,004,081, which interest and amortization charges reduced to a net income of $8,113,541. Sinking-fund and insurance appropriations took $796,670, and preferred and common dividends respectively required $265,536 and $4,938,219, leaving a surplus for the year of $2,113,114. This brought the total surplus at the end of 1925 to $12,964,462. Interest charges of $4,203,024 were earned more than three times. Earnings on common during 1925 amounted to $2.71 a share, against $2.53 in 1924.



GROSS AND NET EARNINGS OF THE PHILADELPHIA ELECTRIC COMPANY

The bonded debt of the company at the end of the past year amounted to $79,964,300. A new issue of $12,500,000 first lien and refunding mortgage bonds was sold last year at 99½ and interest to yield about 5.03 per cent. Common stock outstanding as of March last year amounted to 3,186,813 shares having a par value of $79,670,325, par being $25 a share. Cumulative 8 per cent preferred stock formerly outstanding, which was not converted into common, was retired at $28 a share last September. This also had a par of $25.

The story of the development of Philadelphia Electric is a duplication of that of many of the larger power organizations. Incorporated in 1902 to consolidate the electric light business of Philadelphia, the company was formerly under control of the Philadelphia Electric Company of New Jersey. In 1917 the latter was dissolved and the stock of the new corporation was exchanged on a share-for-share basis. The company now carries on the entire electric light business of Philadelphia and vicinity and of the territory southward to the Delaware border. Power is supplied to the Philadelphia Rapid Transit Company and to other railways. With its subsidiaries the company serves a population of more than 2,100,000.

Savannah Electric & Power to Change Set-Up.—Stockholders of the Savannah Electric & Power Company will vote Oct. 7 on the following proposals: (1)

To authorize a change from the present 25,000 shares of $100 par common stock into 100,000 shares of no par, the new stock to be exchanged for the old in the ratio of four for one; (2) to authorize an increase in the authorized common stock from 100,000 to 200,000 no-par-value shares; (3) to authorize an increase in the first preferred or debenture stock from $1,800,000 to $2,300,000; (4) to authorize directors to sell all or any part of the new $500,000 first preferred or debenture stock and the additional 100,000 shares of common. Of the new common stock, 33,334 shares would be sold at $18 per share to Engineers Public Service, Inc. The $600,000 provided by this sale would be used in part to complete an addition to generating equipment to cost about $2,300,000. Recently $1,700,000 of three-year 5 per cent coupon notes were sold to provide part of the amount required for this improvement. The new preferred stock or debentures would be series C 7 per cent. It would be sold locally in lieu of 7½ per cent of prior series debentures, which the company has hitherto sold within its area of operations. The lowering of the interest rate on the debentures is a reflection of betterment in the company's position and credit, it is explained in the announcement.

Customer Sales Reach $26,887,000 in July

Based upon monthly reports received by the ELECTRICAL WORLD from electric light and power companies selling stock direct to their customers and employees, it is estimated that during July a total of 382,000 shares were sold in this manner. The value of the stock sold is estimated at $26,887,000. A total of 32,400 customers took part in the sales during July.

Los Angeles Municipal Bureau Reports Earnings. — Surplus earnings amounting to $2,796,452 were returned by the Municipal Bureau of Power and Light of Los Angeles during the fiscal year ended June 30, according to an audit report by an accounting firm. The report indicates that the bureau has assets of $57,416,554 and that the surplus earnings of nearly $3,000,000 remain after every deduction for operation, maintenance, depreciation and interest on outstanding bonds. Gross earnings totaling $11,237,159 were returned by the bureau during the fiscal year from the sale of electric energy. Of this sum $5,836,131 was used to meet expenses of operating and maintaining the system, $1,186,106 was set aside for depreciation of the plant and equipment and $1,418,469 was used to meet interest charges on outstanding bonds.

Consolidated Hydro-Electric Reports Earnings.—The report for the year 1925 of the Consolidated Hydro-Electric Works of Upper Wuerttemberg, Germany, just received in this country, shows net operating revenues before depreciation available for interest of $789,990, a figure representing an increase of about 13 per cent over that recorded for 1924. Early this year the Consolidated Hydro-Electric works floated a four-million-dollar loan in the form of 7 per cent first mortgage bonds. The net operating revenue for 1925 amounted to two and eight-tenths times interest requirements on this loan.

Montaup Electric Stock Authorization.—The Massachusetts Department of Public Utilities has authorized the Montaup Electric Company of Fall River to issue additional capital stock to the amount of $3,500,000. Proceeds will be used to reimburse the Fall River

Stock Quotations of Electric Light and Power and Manufacturing Companies

(Prices on New York stock market unless otherwise noted. Unless otherwise noted the par, stated, or preference value of stock is $100.)

Companies	Bid Price Tuesday Sept. 21	Low 1926	High 1926
ABITIBI PWR. & PAPER, com. —no par	95	70½	98
Adirondack Pwr. & Lt.—7% pf.	106	....	....
Adirondack Pwr. & Lt.—8% pf.	113	....	....
Ala. Pwr., pf.	106	....	....
Allis-Chalmers Mfg. pf.	110	105	110½
Allis-Chalmers Mfg., com.	88½	78½	94½
Aluminum Co. of Amer., com.	70½	54½	76
Aluminum Co. of Amer. new, pf.	101	....	....
Amer. & Foreign Pwr., pf. 25% pd.	*m*110	....	....
Amer. & Foreign Pwr., 7% pf.—no par	87½	87½	98
Amer. & Foreign Pwr., com.—no par	18½	15½	42½
Amer. Bosch Magneto, com—no par	20½	16	34½
Amer. Brown, Boveri, Elec.	45½	30½	50
Amer. Brown, Boveri, Elec., pf.	*k* 97	86½	97½
Amer. Elec. pwr., pf.	*m*111	102	111
Amer. Gas & Elec., 6% pf.—no par.	95	....	....
Amer. Gas & Elec., com.—no par.	107½	64	107½
Amer. Lt. & Trac., 6% pf.	108½	105	115½
Amer. Lt. & Trac., com.	217	193	263
Amer. Pwr. & Lt., 6% pf.	98	92	99
Amer. Pwr. & Lt., com.—no par.	*m* 66½	50½	72
Amer. Pub. Serv., 7% pf.	*a* 95½	92	99
Amer. Pub. Serv., com.	50	45	80
Amer. Pub. Utilities, 6% pf.	85½	....	....
Amer. Pub. Utilities, 7% pf.	92	....	....
Amer. Pub. Utilities, com.	70	....	....
Amer. States Sec., A	2½	....	....
Amer. States Sec. B	2½	....	....
Amer. Superpwr., pf.—25	*k* 25½	23	26½
Amer. Superpower, pf.	*l* 95	....	....
Amer. Superpwr., Class A—no par.	30½	19½	37½
Amer. Superpwr., Class B—no par.	31½	21½	39
Amer. Wtr. Wks. & Elec., 7% pf.	106	101½	108½
Amer. Wtr Wks. & Elec., com.—20.	58	43½	74
Anaconda Copper	49	41½	51½
Appalachian Pwr., 7% pf.	95	90	101
Appalachian Pwr., 1st pf., 7%	95	99	102
Appalachian Pwr., com.	78	78	83
Arizona Pwr., 7% pf.	60	....	....
Arkansas Cent. Pwr., pf., $7—no par	*k*105	99	107
Arkansas Lt. & Pwr., 7% pf.	101½	....	....
Arkansas Lt. & Pwr., com.	101½	110	115
Asheville Pwr. & Lt., 7% pf.	*l*106½	100½	107½
Assoc. G. & E., pf.—$3.50—50	50	....	....
Assoc. Gas & Elec., pf.—$6—no par	84	....	....
Assoc. Gas & Elec., Class A—no par	36½	25½	38½
BABCOCK & WILCOX, com.	116	....	....
Binghamton Lt., Ht. & Pwr., pf.	*k*105	105	110
Birmingham Elec. pf.—$7—no par.	104½	....	....
Blackstone Valley Gas & Elec., pf.	103	103	106
Blackstone Valley G.&E., com.—50.	98½	90½	118½
Blaw-Knox, com.	*i* 76	45	76
Brazilian Trac., Lt. & Pwr., com.	*f*123	....	....
Broad River Pwr., pf.	93	....	....
Brooklyn Edison, com.	152½	133	163
Buffalo, Niagara&East.Pwr.,pf.—25.	*l* 24½	....	....
Buffalo, Niagara & Eastern Pwr., com.—no par	*l* 30	....	....
CALIFORNIA ELEC. GENERATING, pf.	92	93	93½
California Ry. & Pwr., pf.	*k* 99	88	115
Carolina Pwr. & Lt., pf.—$7—no par	106	....	....
Cent. & S. W. Ut. 7% pf.—no par	*a* 92½	89½	96½
Cent. & S. W. Ut., pr. ln. pf.—no par	*a* 99	93	100
Central Ariz. Lt. & Pwr., pf.	104	....	....
Central Ark. Ry. & Lt., 7% pf.	100	....	....
Central Ill. Pub. Serv., 6% pf.	*a* 90	87	91
Central Ind. Pwr., 7% pf.	87	85	93½
Central Pwr. & Lt., pf.	98½	....	....
Central States Elec., 7% pf.	92	....	....
Central States Elec., com.	*m*200	200	230
Century Elec., com.	*m*115	110	116
Chicago Fuse Mfg., com., no par.	*a* 31	30	35
Cincinnati Gas & Elec., com.	*g* 89½	88	95
Cities Service, 6% pf.	*l* 89½	86½	89½
Cities Service, pf.B—10.	*i* 7½	7½	7½
Cities Service, pf. BB—100.	*l* 77½	74	79
Cities Service, com.—20.	*l* 44½	37½	44½
Cities Service, Bks. Shrs.—10.	*l* 22½	19½	22½
Clarion River Pwr., pf.	*k* 93	93	95
Cleveland Elec. Illg., 6% pf.	107	....	....
Cleveland Elec., Illg., com.	295	....	....
Colorado Pwr., 7% pf.	*k* 95	96	97
Columbia Gas & Elec., 7% pf.	114	111½	115½
Columbia Gas & E., com.—no par.	81½	63½	90
Columbia Ry., Gas & Elec., 6% pf.	90	65	96
Columbus Elec. & Pwr., 2d pf.	104	....	....
Columbus Elec. & Pwr., com.	275	....	....
Columbus Ry., Pwr. & Lt., 1st pf.	97½	....	....
Columbus Ry., Pwr. & Lt., pf. B.	93	....	....
Col. Ry., Pwr. & Lt., com.—no par.	60	....	....
Commonwealth Edison, com.	*a*139½	135½	145
Commonwealth Pwr., 6% pf.	89	82	89½
Commonwealth Pwr., com—no par.	40½	28½	42½
Conn. Lt. & Pwr., 8% pf.	117	....	....
Conn. Lt. & Pwr., 7% pf.	108	....	....
Cons. Gas of N. Y., pf.—50.	59½	....	....
Cons. Gas of N.Y., com.—no par	107½	87	115½
Cons. Gas Elec. Lt. & Pwr. of Balti., 6% pf.	*e*105½	102	107½
Cons. Gas, Elec. Lt. & Pwr. of Balti. 6½% pf.	*e*109½	108½	111½
Cons. Gas, Elec. Lt. & Pwr. of Balti. 7% pf.	*e*111½	109	113½
Cons. Gas, Elec. Lt. & Pwr. of Balti. 8% pf.	*e*127½	124	128½
Cons. Gas, Elec. Lt. & Pwr. of Balti. com.—no par.	*e* 52½	45	57½
Cons. Pwr. & Lt., 7% pf.	104½	....	....
Consumers Pwr., 6% pf.	97	....	....
Consumers Pwr., 6.6% pf.	103½	....	....
Continental Gas & Elec., 7% pfc. pf	101	....	....
Continental Gas & Elec., 7% pr. pf.	97½	....	....
Continental G.&E., com.—no par.	145	....	....
Crocker Wheeler, com.	20	....	....
Crocker Wheeler, pf.	56	....	....
DALLAS PWR. & LT., 7% pf.	106	....	....
Dayton Pwr. & Lt., 6% pf.	99½	....	....
Detroit Edison, com.	*k*136½	123½	141½
Dubilier Condenser & Rado, com.—no par	5½	4½	11
Dubuque Elec., 6% pf.	94	93	98½
Duquesne Lt., 7% pf.	*d*115	112	115½
EAST, N. Y. UTIL, pf.	103	80	104
Eastern New York Util., com.	65	70	75
Eastern States Power.	14	....	....
Eastern States Power, pf.	89	....	....
Eastern Tex. Elec., 7% pf.	104	....	....
East. Tex. Elec., com.—no par.	75	70	80
Edison Elec. Illum. of Boston, com.	*m*227	207	250
E. Paso Elec., com.—no par.	70	70	94
E. Paso Elec. pf.	100	....	....
Elec. Bond & Share, 6% pf.	*l* 107½	103½	109½
E. Bd. & Share Sec., com.—no par.	*l* 70	56½	86
El. Household Util.	*a* 14½	13	25
Elec. Investors, 6% pf.—no par.	92½	....	....
Elec. Investors, com.—no par.	40½	30½	74½
Elec. Investors, 10% pd. receipts.	20	12	56
Elec. Pwr. & Lt., ctfs. pf.	95½	89½	98½
Elec. Pwr. & Lt., ctfs., 40% pd.	104	....	....
Elec. Pwr. & Lt., ctfs. full pd.	*k*104½	103	110½
Elec. Pwr. & Lt., ctfs., com—no par.	18½	15½	34½
Elec. Refrig.	62½	61½	78½
Elec. Ry. Securities, com.—no par.	*m* 6	4½	10
Elec. Storage Battery, com.—no par.	89½	71½	94½
Elmira Wtr., Lt. & R. R., 7% pf.	99	99	99½
Emerson Elec., pf.	*m*101	100	104½
Empire Dist. Elec., 6% pf.	*l* 88	82	88
Empire Power, A	26½	21	32
Engr. Pub. Serv., pf.—no par.	*m* 96	87	96
Engr. Pub. Serv., com.—no par.	*m* 21½	21½	24½
Eureka Vac. Cleaner, com.—no par.	53	43	56
FAIRBANKS MORSE, pf.	*k*108	108½	115
Fairbanks Morse, com.—no par.	47½	46	59½
Federal Lt. & Trac., com.	30½	28	39½
Federal Light & Traction, pf.	*k* 86½	86	89
Federal Utilities, pf.	*m* 70	....	....
Federal Utilities, com.	*m* 17	....	....
Ft. Worth Pwr. & Lt., 7% pf.	*l*107½	105	108½
GALVESTON-HOUSTON ELEC., 6% pf.	53½	....	....
Galveston-Hstn. El., com.	22½	....	....
Gen.|Elec., com	87½	79	95½
Gen. Elec., special—10.	11½	11	11½
Gen. G.&E., (Del.) com. A no par.	47½	34	59
Gen. G.&E., (Del.) com. B no par.	*m* 45½	45	48½
Gen. G.&E., (Del.) A pf. $8 no par.	*k*108	105½	113
Gen. G.&E., (Del.) A pf. $7 no par.	*k* 98½	95	99½
Gen. G.&E., (Del.) pf. B	*k* 92½	92½	96
General Public Service, pf.	*m*104	90	106½
General Public Service, com.	*m* 12	12	16½
Ga. Lt., Pwr., & Rys., 6% pf.	95	82	98
Ga. Lt., Pwr. & Rys., com.	*m* 70	65	80
Ga. Ry. & Power, 8% pf.	*k*114	112	114
Ga. Ry. & Power, 7% pf.	103	....	....
Ga. Ry. & Pwr., 4% pf.	*k*120	105	145
Ga. Ry. & Pwr., com.	120	....	....
Gt. Western Pwr., 7% pf.	*h*100	....	....
IDAHO PWR., 7% pf.	103½	....	....
Ill. No. Utilities, 6% pf.	*a* 91	90	92
Ill. Pwr. & Lt., 7% pf.	98½	....	....
Ingersoll Rand.	*k* 96	80½	104
Int. Combus. Engr., com.—no par	44½	33½	64½
Int. Utilities, class A—no par.	*k* 30	25	39
Int. Utilities, class B—no par.	4½	3½	9½
Interstate Pwr., pf., no par.	92	....	....
Interstate Pub. Serv., 7% pf.	96½	96½	99
Iowa Ry. & Lt., 7% pf.	95	98	100
JERSEY CENTRAL PWR. & LT., 7% pf.	94	....	....
Jersey Central Pwr. & Lt., pfc. pf.	110	95½	112
Jersey Central Pwr. & Lt., com.—no par	45	45	50
Johns-Manville, com.—no par.	143	130	165

Stock Exchange: *a*Chicago; *b*St. Louis; *c*Philadelphia; *d*Boston; *e*Baltimore; *f*Montreal; *g*Cincinnati; *h*San Francisco; *i*Pittsburgh; *j*Washington. *k*Bid, low, high. Saturday, Sept. 18. *l*Bid, low, high, Wednesday, Sept. 22. *m*Latest quotations available.

Stock Quotations of Electric Light and Power and Manufacturing Companies (Continued)

(Prices on New York stock market unless otherwise noted. Unless otherwise noted the par, stated, or preference value of stock is $100.)

Companies	Bid Price Tuesday Sept. 21	Low 1926	High 1926
KANSAS CITY PWR. & LT., pf..	*k*112	107¼	112¾
Kansas Gas & Elec., 7% pf. ex. div.	*l*102½	99	103
Kentucky Hydro-Elec., pf.	*a* 94	91½	95½
Kentucky Sec., 6% pf.	*k* 78	..	....
Kentucky Sec., com.	99	....	....
Kentucky Utilities, 6% pf.	78	....	....
Keystone Pwr. & Lt. 7% pf.	96½	95	97
LACLEDE GAS LT., com.	159	146	175½
Lehigh Pwr. Sec., com.—no par.	16½	10	22
Long Island Ltg., 7% pf.	107½	....	....
Long Island Ltg., com.—no par.	120	120	150
Los Angeles Gas & Elec., 6% pf.	97	....	....
Louisville Gas & Elec., Class. A	24½	22½	26¼
MANHATTAN ELEC. SUPPLY..	80	56	87½
Manila Elec., com.—no par	44½	27½	45½
Maytag Mfg., com.	23	19	24½
Memphis Pwr. & Lt., pf., $7, no par	108	103	109
Metro. Edison, pf.—$6—no par	92	....	....
Metropolitan Edison, pf., $7, no par.	105	....	....
Metropolitan Edison, com., no par..	45	45	50
Middle West Utilities, 7% pf.	*a*106½	97½	111½
Middle West Utilities, 7% pr. lien pf.	*a*115½	106¾	123½
Middle West Utilities, com.—no par.	*a*114¾	108	134½
Midland Utilities, pr. ln. pf.	*a*102½	98	104
Midland Utilities pf. A	*a* 99	96	99½
Milwaukee Elec. Ry. & Lt., 7% pf..	98	100	102
Milwaukee Elec. Ry. & Lt., 6% pf..	91	87	88½
Minn. Pwr. & Lt., 7% pf.	*l*104	100	104
Miss. Pwr. & Lt., pf.	105	....	....
Miss. River Pwr., 6% pf.	95	....	....
Miss. River Pwr., com.	60	....	....
Mohawk Hudson Pwr., 1st pf.—$7—no par.	102½	....	....
Mohawk Hudson Pwr., 2nd pf.—$7—no par.	99½	....	....
Mohawk Hudson Pwr., com.—no par	23½	20½	28¾
Montana Pwr., pf.	*m*117½	112½	119¾
Montana Pwr., com.	77½	69¾	83½
Montreal Pwr., com.	*f* 73½	....	....
Mountain States Pwr. pf.	97	....	....
Mountain States Pwr., com.	18	....	....
NASSAU & SUFFLOK, LTG., pf.	99	....	....
National Carbon, pf.	*a*125	125	128
National Electric Pwr-A	*a* 24½	19½	26½
National Elec. Pwr., pf.	*a* 94	92	96½
Nat. Lt., Ht. & Pwr., com.	24	22	25
National Lt., Ht. & Pwr., 5% pf....	72	71	73
National Pwr. & Lt., pf., $7—no par.	101½	96	102½
National Pwr. & Lt., com.—no par..	21½	16¾	38½
National Pub. Serv., 7% pf.	91	....	....
National Pub. Serv., pte. pf.	110	....	....
National Pub. Serv., A com.—no par.	*k* 20	15½	24
National Pub. Serv., B com.—no par.	16	10	17½
Nebraska Pwr., 7% pf.	*l*107	103	107½
Nevada-Calif., Elec., com.	*k* 25½	18½	44½
New Brunswick Pwr., pf.	55	30	55
New England Pub. Serv., pr. ln. pf..	99	98	99½
New England Pub. Serv., pf.	89	95½	97
N. J. Pwr. & Lt., 7% pf.	105	104	110
New Orleans Pub. Serv., 7% pf.	103	....	....
N. Y. & Queens Elec. Lt. & Pwr., 5% pf.	89	....	....
N. Y. Central Elec., 7% pf.	97½	98	98½
Newport News & Hampton Ry., Gas & Elec., com.	109	98	112
Newport News & Hampton Ry., Gas & Elec., pf.	109	98	114
Niagara Falls Pwr., 7% pf.—25....	28½	27¼	28¾
Niagara, Lock. & Ont. Pwr., 7% pf...	109	110	111½
No. Amer., 6% pf.—50.	51	49	52½
No. Amer., com.—10.	52½	42	67
No. Amer. Edison pf.—no par.....	*k* 96½	91½	96½
No. Amer. Lt. & Pwr., pf.	*m*101	88	104
No. American Utilities, pf., full pd..	*m* 94½	89	96
No. American Utilities, pf., 25% pd.	*m* 19	18	27
N.C. Pub. Serv., pf.—$7—no par...	92	....	....
Northeastern Pwr., com.	18½	17½	36½
No. Indiana Gas & Elec., pf. A.....	100	98	103
No. Indiana Public Service — pf....	100½	99	103
No. N. Y. Utilities, 7% pf.	104	....	....
No. Ohio Pwr., com.—no par.	14½	11	26½
No. Ohio Trac. & Lt., 6% pf.	80	78	81
No. Ohio Trac. & Lt., 7% pf.	94	88	96
No. Ont. Lt. & Pwr., pf.	83	....	....
No. Ont. Lt. & Pwr., com.	*k* 73	45	75
No. States Pwr., 7% pf.	101	....	....
No. States Pwr. com.	105½	97	136½
No. Texas Elec., 6% pf.	55	....	....
No Texas Elec., com.	20	....	....
OHIO BRASS, com. B—no par...	74	70	79
Ohio Brass, pf.	100	98	101
Ohio Gas & Elec., 7% pf.	94	92	95
Ohio Pwr., 6% pf.	94½	93	96
Ohio Pub. Serv., 6% pf.	*l* 96½	90	96½
Ohio Pub. Serv., 7% pf.	*i* 99	96	100
Ohio River Edison, pf.	101	....	....
Oklahoma Gas & Elec., pf.	96	....	....
PACIFIC GAS & ELEC., 6% pf...	100	....	....
Pacific Gas & Elec. com.	133½	118	133¾
Pacific Pwr. & Lt., 7% pf.	*l*103	98	102½
Parr Shoals Pwr., 6% pf.	92	....	....
Penn Central Lt & Pwr., pf.—no par	*c* 71	71	91
Penn-Ohio Edison, 7% pf.	95	....	....
Penn-Ohio Elec., 7% pf.	95	93	96
Penn-Ohio Pwr. & Lt., 7% pf.	97	94	97
Penn-Ohio Pwr., & Lt., 8% pf.	106	....	....
Penn Pwr. & Lt.—$7—no par.	*l*107½	103	108½
Penn Pub. Serv., 7% pf.	103	96	103
Penn Pub. Serv., 6% pf.	87	85	90
Penn Wtr. & Pwr., com.	*e*160	141	171
Phila. Co., 6% pf.—50.	50	47½	51½
Phila. Co., com.—50.	73	59¾	76½
Phila. Elec. com.—25.	*c* 51	41¼	67½
Pittsburgh Utilities, pf.—10.	*m* 19½	14½	20½
Portland Elec. Pwr., 7% pf.	99½	....	....
Portland Elec. Pwr., 6% pf.	84	....	....
Portland Elec. Pwr., 6% 2nd pf.	71	....	....
Portland Elec. Pwr., com.	31	....	....
Potomac Elec. Pwr., pf.	*l*107½	....	....
Pwr. Corp. of N.Y., com—no par..	*m* 79	77½	90½
Pwr. Sec., pf.—no par.	*k* 23	10	29
Pwr. Sec., com.—no par.	*k* 6	4	13
Pub. Serv. of N. J., 7% pf.	107½	103½	109½
Pub. Serv. of N. J., 8% pf.	*k*121½	115	123½
Pub. Serv. of N. J., com.—no par..	97	72	97½
Pub. Serv. of No. Ill., 6% pf.	*a*102	100½	106
Public Serv. of No. Ill., 7% pf.	*a*115	112	116½
Pub. Serv. of No. Ill., com.—no par	*a*131½	128¾	140
Pub. Serv. of No. Ill., com.	*a*132	129½	143
Pub. Serv. of Okla., 7% pf.	98	92	97
Pub. Serv. Elec. & Gas, 6% pf.	103½	97	104
Public Service Elec. Pwr., pf.	*k*112½	106	114
Puget Sound Pwr. & Lt., 7% pf.	102	....	....
Puget Sound Pwr. & Lt., 6% pf....	83	....	....
Puget Sound Pwr., & Lt., com.	27	....	....
RADIO CORP. OF AM., pf.—50.	*k* 48½	44¼	48¾
Radio Corp. of Amer., com.—no par.	48	32	52½
Republic Ry. & Lt., pf.	107	....	....
Republic Ry. & Lt., com.	85	....	....
Rochester Gas & Elec., 5% pf.	*k* 95	80	98
Rochester Gas & Elec., 6% pf.	101½	....	....
Rochester Gas & Elec., 7% pf.	104	105	107
SAN JOAQUIN LT. & PWR., 7% pf.	97	97½	98½
Safety Cable, com.	*k* 52½	42¼	54½
St. Joseph Ry., Lt., Ht. & Pwr., pf...	67	60	70
Servel Corp.	16	16	22¾
Sierra Pacific Elec., com.	26	23	28¼
Sioux City Gas & Elec., 7% pf.	98½	....	....
S. E. Pwr. & Lt., pf.—$7—no par..	*i* 99	....	....
Southeastern Pwr. & Lt., pte. pf....	*i* 68½	....	....
S. E. Pwr. & Lt., com.—no par.....	29	20	46½
So. Calif. Edison, 8% pf.—25.....	33	32½	33½
So. Calif. Edison, 7% pf.—25.....	27¼	....	....
So. Calif. Edison, 6% pf.—25.....	24½	....	....
So. Calif. Edison, com.	*k* 31½	30½	33
Southern Cities Utilities, 7% pf....	85	....	....
Southern Cities Utilities, com.	34	....	....
Southwestern Lt. & Pwr., A.	60	....	....
Southwestern Lt. & Pwr., B.	60	....	....
Southwestern Lt. & Pwr., $6 pf.	53	....	....
Southwestern Pwr. & Lt., 7% pf....	*k*103	100	105
Springfield (Mo.) Ry & Lt., 7% pf.	99	95	100
Standard Gas & Elec., 8% pf.	56	53½	57½
Standard Gas & Elec., 7% pf.	103	....	....
Standard Gas & Elec., com.—no par.	54½	51	69
Standard Pwr. & Lt., 7% pf.	95	....	....
Staten Island Edison, pf.-$6-no par	95½	....	....
Superheater, com.—no par.	157	....	....
Syracuse Lighting, 7% pf.	102	105	107
Syracuse Lighting, 8% pf.	115	....	....
Syracuse Lighting, com	340	260	355
TAMPA ELEC., com.	50	48	67
Tenn. Elec. Pwr., 6% pf.	90	....	....
Tenn. Elec. Pwr., 7% pf.	102	....	....
Terre Haute, Ind. & East Trac., pf..	20	20	37
Terre Haute, Ind. & East. Trac., com	1	1	7
Tex. Pwr. & Lt., 7% pf.	*l*107½	102	107½
Tide Water Pwr., 8% pf.	102	....	....
Timken Roller Bearing, com—no par	62¾	44½	64¼
Toledo Edison, 8% pf.	*l*113	111	113
Toledo Edison, 7% pf.	*l*102½	101	103
Toledo Edison, com.	100	....	....
Tri-City Ry. & Lt., 6% pf.	87	87½	89
UNITED GAS & ELEC., 6% pf..	97	....	....
United Gas & Elec., com.—no par..	*m* 57	56	66
United Gas & Elec. (N.J.), 5% pf....	72	....	....
United Gas Impr.—50.	*c*111½	84½	144¼
United Lt. & Pwr., pf.—$4—no par.	50	44	51
United L. & P. pf.—$6.50—no par...	87	81	91
United Lt. & Pwr., com., A—no par	*a* 15½	13½	26
United Lt. & Pwr. com., B—no par	*a* 18½	15	31
Utah Pwr. & Lt., 7% pf.	*l*101½	99	103½
Utica Gas & Elec., 7% pf.	104½	....	....
Utica Gas & Elec., com.	200	....	....
Utilities Pwr., & Lt., 7% pf.	91	....	....
Utilities Pwr. & Lt., com A	31	28½	37
Utilities Pwr. & Lt., com. B, ex. div. —no par.	*k* 14	13½	18
VERMONT HYDRO - ELEC., 7% pf.	95	94	96
Virginia Elec. & Pwr., 7% pf.	104	101	105
Virginia Pwr., 7% pf.	*k*108	102	104
Virginian Pwr., com.	*k* 70	65	75
WAGNER ELEC., pf.	*m* 68	61½	85
Wagner Elec., com.—no par.	*b* 17	13¾	34½
Washington Ry. & Elec., com.	*j*195	....	....
Washington Ry. & Elec., pf.	*j* 89½	....	....
Washington Wtr. Pwr., com.	134	130	136
West Mo. Pwr., 7% pf.	92	....	....
West Penn., 7% pf.	115	108	115
West Penn, com.	*m*125	118	130
West Penn Elec., pf.	*k*100	95½	100½
West Penn Elec., Class A.	96½	88½	97
West Penn Pwr., pf.	*k*113	108	114
West Va. Lt., Ht. & Pwr., 7% pf..	94½	95	98
West Va. Uti ities, 7% pf.—50.....	46	43	48
Western Pwr., 7% pf.	97	....	....
Western States Gas & Elec., 7% pf.	92½	....	....
Western States Gas & Elec., com...	16	....	....
Westinghouse El. & Mfg., com—50.	69¾	65	79½
Weston Elec. Instrument, Class A..	*k* 30½	27½	32½
Weston Elec. Instrument, com.	16½	13½	19½
Wheeling Elec., pf.	93	91	97
Wis. Pwr., Lt. & Ht., 7% pf	*k* 90	85	90
Worthington Pump, pf. A.	*k* 65	66	80
Worthington Pump, pf. B.	*k* 51	53	65
Worthington Pump, com.	29½	20½	44½
YADKIN RIVER PWR., 7% pf...	*l*106½	102	107½
Yale & Towne, com.—25.	*k* 70½	60½	72

Stock Exchange: *a*Chicago; *b*St. Louis; *c*Philadelphia; *d*Boston; *e*Baltimore; *f*Montreal; *g*Cincinnati; *h*San Francisco; *i*Pittsburgh; *j*Washington. *k*Bid, low, high, Saturday, Sept. 18. *l*Bid, low, high, Wednesday, Sept. 22. *m*Latest quotations available.

Electric Light Company, the Blackstone Valley Gas & Electric Company and the Edison Electric Illuminating Company of Brockton for advances made to the Montaup company to pay for the construction of its power plant, transmission lines and equipment as well as for the payment of future additions and improvements to its plant and system. At the same time the department authorized the Fall River Electric Light Company to subscribe to 16,761 new shares of common stock of the Montaup company and the Edison Company of Brockton to subscribe to 4,437 shares of this stock.

Public Service Company to Offer Five-Million-Dollar Issue.—The Public Service Corporation of New Jersey has announced plans for another customer-ownership campaign to open Oct. 1. An offering will be made of 6 per cent cumulative preferred stock, amounting to $5,000,000, at par and accrued dividends for cash, or at the rate of $10 a share monthly. Interest at the rate of 6 per cent annually will be paid on installments, and the purchaser will receive the accrued dividends when he completes his purchase. In previous campaigns the company has sold 7 and 8 per cent preferred shares to customers.

Narragansett Officers Oppose Outside Control

Following last week's offer of Bond & Goodwin, Inc., investment bankers, Boston, to pay $86 cash per share of Narragansett Electric Lighting Company (Providence, R. I.) stock, President E. A. Barrows of the Narragansett company issued a statement to stockholders on behalf of the board of directors pointing out that the price offered is the same as that conditionally offered by the Rhode Island Public Service Company in its original tender; that the stock is worth much more than this price, and that the company's business is growing so rapidly that it will be necessary to secure additional capital early in the coming year. This statement further points out that it is fair to assume that the purchase of stock by this concern is looking to the control of the Narragansett company either through the merger plan or, if that does not become effective, by outside interests.

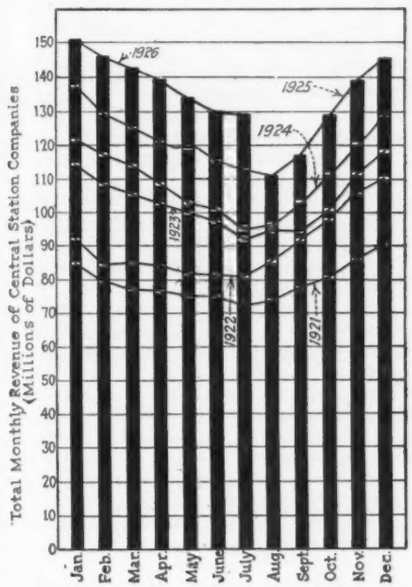
"In recent attempts to buy control of important public utilities," says Mr. Barrows, "the market price of the stock involved has advanced to several times its previous market value. The announcement that Bond & Goodwin will retain the stock or resell it if the merger plan does not become effective is also an indication that they think it is worth in excess of $86 per share. These are possibly speculative features of the present situation, but it is reasonable to give them weight in considering the desirability of selling at the present

offered price. The directors of the Narragansett company believe that neither the merger plan nor control by any outside capital is in the interest of this community or the consumer."

None of the directors is depositing stock under the offer of Bond & Goodwin, Inc.

Central-Station Revenue 13.9 per Cent Over Last Year

Reports received by the ELECTRICAL WORLD from central-station systems representing 75 per cent of the total



generator rating of the industry indicate that the total gross revenue from the sale of energy during the month of July was $128,800,000, an increase of $15,700,000, or 13.9 per cent over the same period for 1925. The operating and maintenance expenses totaled $61,800,000.

Florida Public Service Securities Listed.—The Boston Stock Exchange has authorized the listing of additional 6 per cent first mortgage bonds, series B, of the Florida Public Service Company, dated 1925, and due April 1, 1955.

Massachusetts Lighting Stockholders' Rights.—Acting under authority granted to them by the shareholders, the trustees of the Massachusetts Lighting Companies have voted to issue 11,085 additional common shares and to offer to all shareholders of record at the close of business Sept. 15 the right to subscribe to such new shares in the proportion of one new common share for each ten shares of common or preferred held, at $57.50 per share.

Montreal Company Calls Special Meeting.—Shareholders of the Montreal Light, Heat & Power Company will convene at a special meeting Sept. 29 to authorize a total bond issue of $75,000,000. Should the bonds be ratified it is planned to issue first mortgage 5 per cent twenty-five-year bonds to the amount of $30,000,000 to retire 650,000 shares of 6 per cent preferred stock ($50 par value).

Pacific Coast Utility Makes New Records

Pacific Gas & Electric's Sales Have Risen 173.6 per Cent and Gross Operating Revenues 157.6 per Cent in Ten Years

THE Pacific Gas & Electric Company, which provides service in electricity, gas and water over a huge area in California, is an operating as distinguished from a holding company. Incorporated in 1905, the company has expanded rapidly and today owns all the properties which it operates except a few which are under lease. Last year it served 813,698 customers in a 59,000-square mile area with a population of more than 2,200,000. Sales of electricity totaled more than 1,351,798,000 kw-hr., which represents a gain in ten years of 173.6 per cent.

The Pacific Gas & Electric's remarkable growth of the past ten years continued during the first half of 1926. Gross income for this period was $24,999,412—a yearly rate of about $50,000,000. The 1925 figure was $47,729,079. Operating expenses for the first half-year were $14,921,381, leaving a net for fixed charges, of $10,078,032. This represents an operating ratio of 60 per cent against one of 43 per cent for 1925, which is nearer the normal for a company of this type.

Net earnings for 1925 were $18,830,367, against $16,248,490 in 1924 and $11,024,321 in 1921. Bond and other interest, amounting to $7,078,183, was, therefore, earned two and three-fifths times—a ratio well above the general average, but not quite in line with that of certain of the larger companies, some of which earn their interest charges four times. The future outlook for earnings is excellent. After bond interest there remains $11,752,184 available for preferred dividends, which required only $3,265,434, allowing a ratio well above the average, which is about three to one. The balance available for common dividends provided for earnings of $9.67 a share.

The capital structure of Pacific Gas & Electric has the advantage of simplicity. The face value of all securities outstanding last December was $264,900,180, which is five and a half times gross earnings—little more than an average ratio for this type of company. The funded debt accounts for $161,852,800, which is 61 per cent of the total and three and two-fifths times gross earnings. The debt is followed by $54,916,532 of preferred stock and $48,130,848 of common.

A distinct improvement is evident in the company's relationship between physical assets and capitalization. In the past decade the actual cost of properties added to the system, after deducting $13,965,352 for realized depreciation, was $157,751,568, while the total par value of bonds and stocks was increased by only $132,105,122.

Pacific Gas & Electric's combined maintenance expenditures and depreciation reserves in 1925 were $7,337,119, which appears adequate to keep the equity behind the securities unimpaired, being 15.4 per cent of gross earnings. During the ten-year period provision for upkeep aggregated $53,515,716, or 16 per cent of the total receipts from operation. The equipment and properties of the company have thus been kept in good condition.

During the twenty years since organization the balance of earnings after deducting all costs was $112,955,585. Of this 41.7 per cent was paid in cash dividends and 37.8 per cent used to retire bonds or reinvested.

Dividends Declared

The quarterly dividends listed below have been announced by electric light and power and electrical manufacturing companies:

Name of Company	Per Cent	When Payable
Abitibi Power & Paper, pf.	1¾	Oct. 1
Alabama Power, 7% pf.	1¾	Oct. 1
Alabama Power, 6% pf.	1½	Oct. 1
American Brown Boveri Elec., pf.	1¼	Oct. 1
American Gas & Electric, com.	.25	Oct. 1
American Gas & Electric, pf.	$1.50	Nov. 1
American Power & Light, pf.	$1.50	Oct. 1
Arkansas Central Power, pf.	$1.75	Oct. 1
Barcelona Trac., Lt. & Pwr., ptc. pf.	1¾	Sept. 30
Central Illinois Lt., 6% pf.	$1.50	Oct. 1
Central Illinois Lt., 7% pf.	$1.75	Oct. 1
Cities Service, com*	½	Nov. 1
Cities Service, com†	½	Nov. 1
Cities Service, pf. and pf. B*	½	Nov. 1
Cities Service bankers' shrs*	½	Nov. 1
Coast Valleys Gas & Elec., 6% pf.	1½	Oct. 1
Coast Valleys Gas & Elec., 7% B.	1¾	Oct. 1
Consumers Power, 6% pf.	1½	Jan. 2
Consumers Power, 6.6% pf.	$1.65	Jan. 2
Consumers Power, 7% pf.	1¾	Jan. 2
Consumers Power, 6% pf*	.50	Nov. 1
Consumers Power, 6% pf.*	.50	Dec. 1
Consumers Power, 6% pf.*	.50	Jan. 2 '27
Consumers Power, 6.6% pf.*	.55	Nov. 1
Consumers Power, 6.6% pf.*	.55	Dec. 1
Consumers Power, 6.6% pf.*	.55	Jan. 2, '27
Dominion Power & Trans., pf.	1¾	Oct. 15
Electric Controller & Mfg., com.	$1.25	Oct. 1
Electric Controller & Mfg., pf.	1¾	Oct. 1
Electric Public Service, pf.	1¾	Oct. 1
Electric Vacuum Cleaner, com. (ex.)	$1	Oct. 1
El Paso Electric, pf. A	1¾	Oct. 15
El Paso Electric, pf. B	1¾	Oct. 15
Empire Power $6 pf.	$1.50	Oct. 1
Illinois Power, 6% pf.	1½	Oct. 1
Illinois Power, 7% pf.	1¾	Oct. 1
Jamaica Public Service, pf.	1¾	Oct. 1
Jersey Central Pwr. & Lt., pf.	1¾	Oct. 1
Kansas Gas & Elec., pf.	1¾	Oct. 1
Long Island Ltg., pf.	1¾	Oct. 1
Massachusetts Ltg. Cos., com.	.75	Sept. 30
Massachusetts Ltg. Cos., 6% pf.	1½	Oct. 15
Massachusetts Ltg. Cos., 8% pf.	2	Oct. 15
National Public Service, pf. A	1¾	Oct. 1
National Public Service, ptc. pf.	1¾	Oct. 1
New England Power Asso., com.	37½	Oct. 15
New England Pub. Serv., pf.	$1.75	Oct. 15
New England Pub. Serv., pr. ln. pf.	$1.75	Sept. 15
New York Central Elec., pf.	1¾	Oct. 1
Northeastern Power, cl. A	$1.50	Oct. 1
Northern N. Y. Utilities, com.	.75	Sept. 29
Pacific Gas & Elec., com.	2	Oct. 15
Panama Power & Light, pf.	1¾	Oct. 1
Philadelphia Co., com.	$1	Oct. 30
Philadelphia Co., 6% pf.	$1.50	Nov. 1
Public Service Electric Power, pf.	$1.75	Nov. 1
Puget Sound Power & Light, pf.	1¾	Oct. 15
Puget Sound Power & Light, pr. pf.	1¾	Oct. 15
Southwestern Gas & Elec., 7% pf.	$1.75	Oct. 1
United Light & Power, old com. cl. A and B	.60	Nov. 1
United Light & Power, new com. cl. A and B	.12	Nov. 1
United Light & Power, pf. cl. A	$1.63	Oct. 1
United Light & Power, pf. cl. B	$1	Oct. 1
Virginia Public Service, 7% pf.	1¾	Oct. 1
Washington Water Power	2	Oct. 15
Western Electric	2½	Sept. 30

* Monthly.
† Payable in common stock.

Manufacturing and Markets

Trade Associations and What They May Do

Attorney Lists Eleven Activities Permitted Under Supreme Court's Ruling—These Outnumber Forbidden Acts and Are of Real Value

BY FRANCIS NEAGLE*
Of Rounds, Dillingham, Mead & Neagle, Attorneys-at-Law

THE proposed Electric Refrigeration Council group is remarkable in industry association work in that its co-operative work began almost at the beginning of the domestic electric refrigeration industry. There was not the usual waiting until antagonisms among the members of the industry rendered co-operation necessary. It is also remarkable in that the first co-operative effort of the group—industry advertising—was for the benefit of the whole industry and not simply for the benefit of the few companies making up the group. It is the first instance I know of where joint advertising for many was carried on at the expense of a few.

The Century Dictionary defines co-operation as "the act of working together to one end." When a lawyer discusses, as I have been asked to do, the subject of co-operation many of those not acquainted with the work of trade associations immediately ask: "Wherein does a lawyer aid in industry co-operation? Most of their work consists in saying what you cannot do." That this is not the fact men who have been members of trade associations can well testify.

Mr. Justice Holmes of the Supreme Court of the United States is reported to have said that a good lawyer is one who upon a given state of facts can best guess what the court of last resort will decide is the applicable law. Many aspects of trade association law are not covered by judicial decisions, and a lawyer dealing with trade association problems is always confronted with the fact that many prosecuting officials believe that the sole aim of any trade association is to fix prices and restrain competition, and every effort of a trade association to improve conditions in its industry is adjudged by this ill-founded conviction.

In the realm of industry statistics the Supreme Court in its recent decisions in the Maple Flooring Manufacturers' Association case and in the Cement Association case has greatly clarified the legal situation. The Supreme Court in these two cases for the first time recognized that the laws of economics were not intended to be subverted by restrictive judicial decisions. It realized that the possession of complete information by all the members of an industry tended toward the stabilization of prices in that industry, and it held that the fact that these statistics were collected by an association did not, *ipso facto*, make them illegal so long as these statistics were available not only to the manufacturers collecting them but also to the public.

*Paper read before the Electric Refrigeration Council meeting at "Waldenwoods," near Detroit, Sept. 10-12, 1926.

PERMISSIBLE ACTIVITIES

I have heard many times that the permissible activities of trade associations were few and that the forbidden activities were many. With this I thoroughly disagree, for in my opinion there are more permissible activities than forbidden activities. Shortly stated, forbidden activities are those which affect free competition and which prevent the ultimate buyer from obtaining every possible advantage by reason of competitive sales effort among suppliers. These non-permissible activities include, of course, fixing of prices, maintenance of resale prices by contract, agreement or understanding, maintenance of fixed discounts, maintenance of fixed guarantees, limitations upon free service, limitations upon "trade-ins," etc. The permissible activities, however, far outnumber the forbidden ones:

1. There is open to a trade association legislative activities looking toward the passage of laws which will aid the industry and working against the passage of laws which will restrict the industry.

2. There is a wide field of standardization open—the standardization of nomenclature, of sizes, of capacities, of ratings, of types of machines, etc.

3. Simplification—that is, the cutting down of the number of different sizes and types of apparatus which may be purchased—is not a permissible activity by a trade association; but if a trade association feels that simplification is an advisable thing, such simplification can be effected through the Department of Commerce after a conference at which the manufacturers, the government, the public and other agencies are represented.

4. Uniform cost-accounting methods may be worked out and put into effect by a trade association. With such uniform cost accounting, if followed by the members of the association, statistics of cost which may be collected by the association are rendered completely useful by reason of the fact that every one knows that such statistics are based upon the same method of accounting.

5. Trade associations may engage in collecting and disseminating credit information and may also engage in the work of a collecting agency for its members.

6. Slogans may be adopted by a trade association for use by its members, just as the members of the proposed Electric Refrigeration Council will be able to use the slogans "To protect food is to protect life" and "Electric refrigeration—a way to better living."

7. Trade associations may maintain information bureaus for the purpose of giving the public information with regard to their industry and the companies in that line engaged in making particular apparatus.

8. Traffic and transportation problems, classification of freight rates, of freight, etc., are better handled through an industry organization than by individual companies.

9. A trade association may carry on commercial research in a way that is ordinarily not possible for an individual company because there is an interchange of ideas among representatives of various companies which results in commercial problems being threshed out from all angles.

10. Trade associations again may carry on programs of educational research, such as the proposed work to be carried on by the Department of Agriculture for the members of the proposed Electric Refrigeration Council.

11. And, finally, trade associations may engage in what I believe is one of the most important functions of a trade association at the present time, and particularly in the case of the electric refrigerating industry, because of its newness and because of the tremendous increase in a short period of time of the number of units that have been sold and installed—the collection of industry statistics.

DISSEMINATION OF STATISTICS

In connection with statistics it must be remembered that the Supreme Court of the United States in the Maple Flooring Manufacturers' Association and Cement Association cases has laid down the rule that statistics to be legally collectible must be available not only to the members of the association collecting them but to the press and to any one who may desire to have them. Another requirement of statistical compilations is that the statistics of any one company be not identifiable.

After the decisions of the Supreme Court in the cement and maple flooring cases it was said by some that the door was wide open for the collection and dissemination of statistics, but this, in my opinion, is exactly contrary to the fact. The Department of Justice has recognized and adopted the rule laid down by the Supreme Court in the two cases mentioned and has announced that in view of the fact that trade associations have been furnished with guideposts for their statistical activities, any association violating the law will be more severely dealt with than before, because its action will indicate a con-

scious attempt to carry out illegal purposes.

Statistics may be collected as to production, as to the quantity produced and as to the percentage of total available production obtained in any given period. Employment conditions likewise may be the subject of statistical activity. Such conditions would include the number of workers by classes, the average hours per day or week of employment of the workers, the average wages by classes and the labor turnover. Statistics of shipments made can also be properly collected, whether by units, by classes of units, by total value, by price per class, by geographical distribution, or by classes of customers; that is, jobber, contractor-dealer, central station or consumer. Knowledge of orders received or sales made may likewise be obtained through statistics. These statistics may cover unfilled orders on hand at the beginning of the statistical period; new orders received during the period and unfilled orders on hand at the close of the period. In the same way sales information may be collected.

There may be statistics of stocks on hand. There may be statistics of canceled orders, which in a time of industrial crises would be very valuable. Prices likewise are the subject of statistical activity—prices of raw material, prices of finished goods and the prices on completed contracts where units are sold in quantity. And, lastly, there may be statistics as to costs of production, of selling, of management expense, etc.

Business Conditions

OUTSTANDING in the news of the electrical markets this week are the reports of extensive buying by the utility companies in New England, in the Southeastern States and in the Middle West, with evidence that construction work is being pushed to insure completion before winter closes down. In New England the greatest activity is in the negotiation stage, embacing a 30-mile transmission line out of Boston, to cost $3,500,000, and many inquiries for turbo-generator units. One power company in Chicago averaged purchases of $65,000 a day this week, while Atlanta reports sales of substation equipment totaling $22,000, line material worth $12,000 and $10,000 in steam-plant lines; also transformer and circuit-breaker sales aggregating $140,000. Industrial buying continues good. There was a general drop in prices on supply lines on the Pacific Coast. The havoc wrought by the hurricane in Florida will undoubtedly bring heavy demands upon the market for line construction and wiring material, but it is too early to allow any estimate to be made.

In New England cable, wire and cross-arms are in strong demand. Small-motor sales totaled $85,000 for the week. Fixtures are moving well with a quickening in radio and appliances. The New York district has been quiet with little utility buying but considerable activity in small motors. Large sizes of motors, however, were less in demand this last week. Construction material and substation equipment are selling strong in the Southeast. Sign business, too, is active and there has been some good industrial business. The Chicago section has been steady, with substantial power company buying and good activity in the industrial field. Steel mills and the railways show increased needs and building construction continues strong. In the St. Louis section domestic appliances are leading the market. On the Pacific Coast orders have been good in number and variety. Three Diesel-electric ferryboat equipments for San Francisco were sold this week, and interesting municipal requirements were announced both in California and in the Northwest.

New England Market Busy with Negotiations

The volume of inquiries received by manufacturers in New England during the past week was heavy. Negotiations are under way for several large orders of equipment and supplies, of which one is of interest, consisting of supplies for a 30-mile transmission line extending from the Edgar plant of the Boston Edison company to Medway and involving, when completed, about $3,500,000.

Considerable stocking up by substations for standard material is reported by one manufacturer. Cable, wire and cross-arms are in steady demand, and a number of piecing-out orders are recorded for this material.

Negotiations for turbo-generators are progressing favorably. It is reported by one manufacturer that the number of probable installations of this type of equipment, in view of the present volume of inquiries, will show a large gain over last year's fall business. Heavy driving equipment and power motors are well covered for this district, but the call for small motors keeps up and shows little falling off. As compared with last week, the sales of one manufacturer are about even in volume; another reports two outstanding orders, one from a manufacturer of power tools, another from a machine manufacturer. For the district, small-motor sales reached over $85,000, an encouraging trend.

Industrial electric heating is progressing and a number of orders for furnaces and melting pots will be placed shortly. As reported from one source, this fall will bring much activity, as metal users are manifesting keen interest in this equipment.

New-construction material sales are steady. Lighting fixtures dominate this division of supplies and are moving well. Street-lighting projects are under consideration by a number of central Massachusetts cities. Interest in electrically driven pumping units is reported by one distributor, and elevator motive equipment is under consideration by a number of engineers. It is recorded by one firm that the number of elevator installations in this district, all electric, will be 100 per cent over the number for last year.

Household appliance sales are gathering momentum owing to a number of sales campaigns now running. Ranges are strong; irons are in good demand and portable lamps are showing good results. Radio supplies are attracting rapidly increasing interest.

Quiet Week Experienced in New York District

Both sales and inquiries have been quiet in the New York district during the past week. Central-station buying is very slow in all lines, and the amount of inquiries coming from this source is also small. Generating equipment, transformers and pole-line materials are particularly weak. Some orders for switching apparatus have been placed recently, and there is a fair demand for meters. Orders for small motors for industrial uses continue strong, and the demand for motors larger than 10 hp. is better. Sales of control apparatus are good, although slightly weaker than last week.

Industrial Market Active in Middle West

General business in the Middle West appears comparatively quiet this week. However, activity in the industrial market continues and utility purchases are quite heavy, as indicated by the purchases by one large utility company, of over $65,000 per day. Good reports are received from the steel industry in this district and the railroads are buying track material quite heavily, one road placing 40,000 tons of rails and requesting quotations on 160,000 tnos. One transit company placed an order for 2,000 refrigerator cars. No recession in building activity is apparent, as every effort is being made to complete work now in progress before cold weather. The various power companies are busy with construction work and it is expected that considerable will be done during the fall and winter months. There has been very little demand for apparatus, although one utility company purchased a 280-kva. booster set this week. The demand for poles, pole-line hardware and meters has been normal.

Jobbers' sales in the Chicago district continue good. There has been a fair demand for small motors and a good demand for conduit and wiring devices. Appliances are moving steadily with a particularly good demand noted for toasters and cool weather appliances. Vacuum cleaners continue to move steadily, one jobber placing an order this week for 1,000 machines. Incandescent lamp sales are increasing with the shorter daylight hours and a particularly large demand is noted for decorative lamps in the sprayed colors. No. 14 single-braid solid code wire was reduced in price approximately 4 per cent today.

St. Louis jobbers and retailers say that appliances are leading all other departments of electrical business. For the past week, radio sets and equipment have a good lead, but heating and cooking appliances have been going out in good volume, closely followed by all

the other electrically driven, or heated, domestic equipment. There has been a marked slowing up of the movement of all classes of construction materials, however, the heavy buying in July and August having temporarily saturated the market.

One of the large manufacturers reports the sale of four-100-hp. and four 50-hp. synchronous motors to one of the largest manufacturers of fireclay products in central Missouri. Another order, amounting to over $75,000, has been placed for motor-driven crushing machinery to be installed by a large quarry company not far from Alton, Ill.

Power Companies Buying Heavily in Southeast

Purchases by central-station companies have been the strongest feature of the electrical market in the Southeast during the past week. The extensive construction programs of the larger power companies are reflected in the very satisfactory movement of practically all lines, particularly pole-line materials and substation equipment. One company placed an order for poles and wire amounting to $12,000 and two orders for substation equipment which will aggregate over $22,000. Another interesting order embraced $10,000 worth of steam-plant equipment to go into the remodeling of one of the steam auxiliary stations of a large power company.

Transformers have been particularly active of late, the largest single order during the past ten days being for four auto-transformers amounting to $75,000. Two orders for 2,000-kva. transformers, totaling $56,000, and an order for eight 38,000-volt transformers are also in hand. The volume of inquiries for transformer equipment is reported very satisfactory. Oil-switch protective equipment has been active of late, and an order for $10,000 worth of oil circuit breakers materialized a few days ago.

A power contract was signed this week for a new 300-loom silk knitting mill in Georgia and construction and equipment contracts are to be let next week. Central-station efforts have served to stimulate activities in electric sign lines, and besides a good volume of small installations some larger orders are reported. Contract was let the past week for one installation of two signs, each 150 ft. long with 8-ft. lettering. Another sign installation to be undertaken in the immediate future will cost in excess of $5,000 when completed.

The hurricane which hit Florida last week has caused an immense property damage and will necessitate a large replacement of power lines, lamps, etc., but a definite estimate of the cost cannot be made at this time. One company in Birmingham is sending a man down to Mobile to try to get 30 carloads of Southern creosoted pine poles shipped to the Florida Power & Light Company immediately. This means about 3,000 poles. The disaster is certain, like the proverbial ill wind, to blow good to manufacturers in the shape of costly orders for transformers and transmission-line equipment of every kind.

Much Business Reported from Pacific Coast

The past week on the Pacific Coast has been of especial interest because of the number and variety of orders for electrical machinery in the California district. These included two 150-hp. motors and one 100-hp. motor for a Sierra paper mill and two crane motors of 25 hp. for a lumber mill. Despite a depression throughout the lumber industry because of low prices and high overhead, the companies are buying machinery and supplies briskly, using this period of temporary shutdown for general overhauling. Three more arc-welding sets were sold. The Modesto irrigation district bought $9,000 of induction-regulating equipment for voltage control, and the city of Roseville bought two feeder-voltage regulators worth $1,200 each for its municipal plant. The early sale of several more such regulators to various plants is predicted, their use on the lines of the large systems having stimulated the smaller companies. The outstanding item of the week, in public interest at least, was the sale of three electric propulsion equipments to the Golden Gate Ferry Company for the San Francisco ferries to Alameda. These equipments average $50,000 each and cover electric drive for Diesel engine and low-speed direct-current motors for field propeller control and necessary switching equipment. There has been a sharp price flurry affecting the entire coast in which such outstanding staple items as ½-in. conduit, ¾-in. flexible conduit, No. 14 single-braid solid wire, 2½-in. loom boxes and the like, probably 40 items in all, decreased from 5 to 10 per cent in dealer's cost with practically no restrictions as to requisite quantities.

Central-station and industrial buying in Seattle and Puget Sound cities have been light with the exception of lamps for industrials and wiring and schedule materials for building. Last week no sales of generating equipment or motors were reported, although specifications were issued for a 300-hp. pumping plant for the Lake Chelan reclamation district. The city of Seattle asked for bids for 25 tons of solid copper wire and two 237,500-hp. turbines, including transformers, switching equipment, etc., costing $2,689,500.

Metal Markets Sluggish—Prices Generally Off

Non-ferrous metals have been sluggish through the week, except for some heavy buying in copper on Wednesday. Prices generally have tapered off somewhat, although lead has almost held its own. The volume of sales has been much less than last week. Metal consumption continues on as large a scale as ever, but advance orders are somewhat smaller.

The heavy buying of copper last week proved to be temporary. Prices held until Wednesday at 14.30 to 14.32½ cents delivered in the East, but the business was small. Consumers seem disinclined to buy except for immediate requirement, but the general feeling is that better buying must soon develop.

NEW YORK METAL MARKET PRICES

	Sept. 15, 1926 Cents per Pound	Sept. 22, 1926 Cents per Pound
Copper electrolytic	14.325	14.274
Lead, Am. S. & R. price	8¾	8.75
Antimony	16½	16–14¼
Nickel, ingot	35	35
Zinc spots	7.45	7.75
Tin, Straits	69¾	69.125
Aluminum, 99 per cent	27	27

Base copper price Sept. 15, 1926, 16¼ cents.

Lead is quiet and easier, although the volume of business has increased somewhat. The American Smelting & Refining Company continues its official contract price in New York at 8.75 cents. A fair supply is selling in St. Louis at 8.45 cents or even 8.42½ cents. There seems to be an expectation that the reduction made last week in the Smelting company price is more apt to be followed by further declines than by an increase. Zinc prices held steady until Tuesday, when a lull in buying caused a slight shading of prices. The metal was freely offered on Wednesday at 7.40 cents, with bids at 7⅜ cents. Most of the business has been for September or October shipment.

Activities of the Trade

R. A. Lister & Company and Peet & Powers Unite

R. A. Lister & Company, Inc., New York, announce that in order to take care of the increase of business in the sale of Lister-Bruston automatic electric lighting plants in this country, they have completed arrangements for combining their present staff with that of Peet & Powers, Inc., electrical engineers, who have carried out many of their installations. This arrangement, it is announced, will afford a still more complete service to all Lister-Bruston clients and agents. The Lister-Bruston business will in future be conducted under the name of Peet & Powers, Inc., 70 East Forty-fifth Street, New York, under the joint supervision of their directors and L. Burbidge, who has been president of R. A. Lister & Company, Inc., since the incorporation of the firm. The general policy for the sales and service of the Lister-Bruston plants will remain unchanged, plants and spare parts being carried in stock as previously.

Winchester Repeating Arms Acquires Dunham Corporation

Controlling interest in the George W. Dunham Corporation of Utica, N. Y., manufacturer of the Dunham "Whirldry" washer, has been purchased by the Winchester Repeating Arms Company, New Haven, Conn. The Dunham organization will retain its identity as a separate company but will move to the Winchester plant at New Haven. The new board of directors is headed

by Louis K. Liggett, president of the United Drug Company. The other members are Charles S. Sargent, Jr., of Kidder, Peabody & Company; William A. Tobler, vice-president of the Winchester company; Edwin Pugsley, factory manager, Winchester; R. C. Swanton, purchasing agent, Winchester, and A. James Eckert of Utica, a former director of the Dunham corporation.

The officers of the company are: William A. Tobler, president; George W. Dunham, Edwin Pugsley and James McClymont, vice-presidents; Henry Brewer, secretary, and L. H. Thompson, treasurer. George W. Dunham, inventor of the "Whirldry" washer, who becomes vice-president and director of the new concern, will continue in charge of engineering. James McClymont, former vice-president and sales manager of the Dunham corporation, will continue under the new régime as vice-president in charge of sales. This combination brings to the Dunham corporation all the resources, manufacturing ability and strength of the Winchester company, comprising an extensive distributing system with ten warehouses scattered throughout the country, besides salesmen and connections in all the leading foreign countries.

Roller-Smith Company Makes Appointments

The Roller-Smith Company, 233 Broadway, New York, announces the appointment of the following new agents:

The Robinson Sales Company, Polson Building, Seattle, for the State of Washington and most of Oregon. The Robinson Sales Company has been handling Roller-Smith apparatus on a sub-agency basis for some time and therefore is well equipped to represent the Roller-Smith Company in the territory designated.

The Ashida Engineering Company, Ltd., Daini, Osaka, Japan, for Japan (including Korea and Manchuria). The Ashida Engineering Company is one of the most important concerns in Japan importing electrical apparatus from the United States, and its experience has been along lines such as are made by the Roller-Smith Company, namely, electrical measuring and protective apparatus. Through this new connection the Roller-Smith Company confidently expects a large increase in its Japanese business.

The Westinghouse Electric & Manufacturing Company has taken out a permit to erect a new two-story addition to its plant at East Springfield, Mass.

The American Brown Boveri Electric Corporation, Camden, N. J., has established four district offices, located respectively at 165 Broadway, New York; 230 South Clark Street, Chicago; 842 Summer Street, Boston, and 922 Witherspoon Building, Philadelphia.

The Apex Electrical Manufacturing Company of Cleveland has purchased the Apex Products Company of Chicago, and two well-known makes of electric household appliances have thus become merged. For many years these companies have been separate firms manufacturing "Apex" vacuum cleaners, washing machines, ironers, etc. According to C. G. Frantz, president of the Apex Electrical Manufacturing Company of Cleveland, the purchase of the Chicago Apex company means an enlarged production of a complete line of home appliances under the one trade name "Apex."

Ferranti Limited of Hollinwood, England, has established a branch office at 130 West Forty-second Street, New York. The name of the American branch will be Ferranti, Incorporated.

The General Electric Company announces that the Electric Supply & Equipment Company, 392 Elm Street, Buffalo, N. Y., and 1405 State Street, Erie, Pa., has been appointed distributor for the company's merchandise products since Sept. 1.

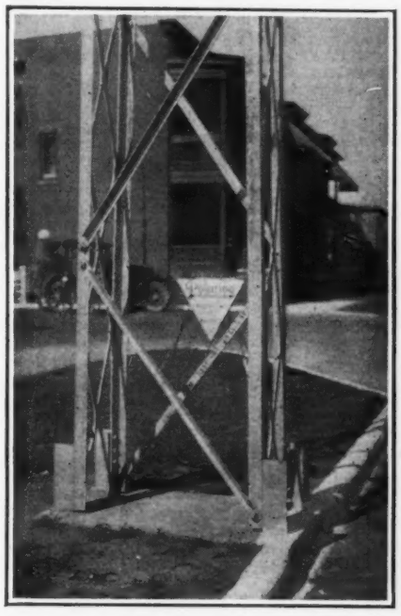
The Absolute Con-Tac-Tor Corporation is moving into its new plant now building at Elkhart, Ind. This is a one-story building of tile and brick construction with a steel roof and with skylights. Part of the manufacturing departments have already begun operations in the plant, and the office and shipping departments were moved last week. All of the manufacturing operations will be established there by the first of November.

New Equipment Available

Semi-Fabricated Pole

A departure from the conventional steel pole or even the simple expanded-steel pole is becoming evident in various parts of the United States and foreign countries, not only in cross-country distribution but also in city transmission where safety, appearance and restricted dimensions are paramount considerations. It is a semi-fabricated pole composed of one-piece double-expanded sections fastened together by other structural members.

One example of this construction is afforded at Michigan City. Ind., where high-voltage lines are carried through the city on this type of pole by the Northern Indiana Gas & Electric Company. The accompanying illustration shows the construction.



SEMI-FABRICATED STEEL POLE

The design, which was developed by the Bates Expanded Steel Truss Company, obviates the necessity of handling heavy or unwieldy pieces without demanding excessive assembly work. The main side members are composed of one-piece double-expanded steel sections of comparatively light weight and convenient handling length spliced end to end. The only bolts required are those used in the splices, at the base, and for securing the structural pieces which join the two main side members. As a consequence the number of bolter joints and inaccessible lapped surfaces is minimized and the disadvantages of eccentric fabricated connections are avoided.

Erection of the assembled pole is simple. It is assembled with its base lying between the foundation stub extensions and the top of the structure pointing in the direction of the line. From this position it can be raised into a vertical position by hinging it on bolts passing through the base and stub extensions.

The double-expanded steel sections differ from the original single-expanded truss in that the lacing between channels forms a criss-cross design instead of diagonals, thus doubling the number of intacts of truss contacts and shortening the unsupported length of webbing between channels. This construction increases the compression value of the flanges, which in the completed structure become corner members.

New Mill-Type Compensator

To meet the demand for a compensator which will cover ratings above 30 hp. on 220-volt circuits and 60 hp. and up on 440-volt and 550-volt circuits, the General Electric Company has introduced a new design designated as size No. 2. Two-part construction is employed in order to meet a wide variety of installation requirements. One unit of the compensator consists of an oil-immersed, double-throw switch with temperature overload relay, push-button station and undervoltage release. The other unit consists of an auto-transformer. Each unit is provided with a conduit box. The control box is so arranged that the oil box may be lowered to allow examination of the switch parts and renewal of fingers and wedges. This unit can be wall-mounted or attached to a pipe support. The auto-transformer is inclosed in a cast-iron box with a removable cover to allow changing tap connections when desired. The conduit box mounted on the top of this case provides ample room for making connections. The front of the condit box is removable, the entire interior thus being accessible in order that joints may be tightened and properly taped.

New Trade Literature

UTILITY EQUIPMENT.—The James R. Kearney Corporation, St. Louis, is distributing a catalog covering its overhead and underground utility equipment, including screw-type anchors, solderless service connectors, porcelain expulsion plug cut-outs, guy-wire clips, etc. This catalog is in loose-leaf form and will be augmented with new bulletins as new items of equipment are ready for distribution.

ACCOUNTING MACHINES. — "Conservation" is the title of a bulletin issued by the Elliott-Fisher Company, 342 Madison Avenue, New York City, in which it calls attention to the use of the various types of the Elliott-Fisher machines in accounting departments of public utility industries. Illustrations showing various applications of the Elliott-Fisher machines are included.

BOILER METERS. — Bulletin No. 43 issued by the Bailey Meter Company, 2,015 East Forty-sixth Street, Cleveland, describes its various types of meters for boiler-room use. It contains illustrations showing applications of the meters in various plants and line drawings showing the mechanism and parts of the instruments. Chart reproductions giving a record of operating conditions of a number of installations are included.

Foreign Trade Opportunities

Following are listed opportunities to enter foreign markets. Where the item is numbered, further information can be obtained from the Bureau of Foreign and Domestic Commerce, Washington, by mentioning the number:

Purchase is desired in Berlin, Germany (No. 22,275), of automobile and airplane electrical equipment. Purchase and agency is also desired (No. 22,265) for electric household appliances, electric refrigerators, small electric motors and portable electric tools.

Purchase is desired in Montevideo, Uruguay (No. 22,276), of electric plant (two units), with Diesel-type combustion engines, directly connected to generator.

Purchase is desired in Leicester, England (No. 22,262), of electric household appliances and electric refrigerators.

Purchase is desired in Melbourne, Australia (No. 22,222), of electric household appliances and small electric motors and radio sets and parts. An agency is also desired for electric refrigerators.

An agency is desired in Buenos Aires, Argentina (No. 22,226), for electric light and power-plant equipment.

Construction News

Projects, Plans, Bids and Contracts, Contemplated or Under Way

New England States

BILLERICA, MASS. — The Boston & Maine Railroad Company, Boston, plans to install electric power equipment in its proposed local boiler and plate shop, to cost about $400,000. F. C. Shepherd is chief engineer.

BOSTON, MASS. — The Massachusetts Lighting Companies plan extensions and improvements in plants, transmission and distributing systems, to cost about $350,000.

EAST LEE, MASS.—The hydro-electric plant and water privileges of the Tay Ford Company have been acquired by the Mountain Mill Paper Company. The contract for erecting a high-tension line to connect the two plants has been awarded to Z. Harding & Son, Lee.

FALL RIVER, MASS.—Plans have been prepared by the American Thread Company for an addition to the power plant at its Kerr mills, to cost about $8,500.

NEWTOWN, MASS.—Sketches are being made by Densmore, LeClear & Robbins, Park Square Building, Boston, for hospital buildings, including nurses home and power plant, for the Newtown Hospital, on Beacon Street, to cost about $1,500,000.

Middle Atlantic States

ALBANY, N. Y.—The installation of ornamental lamps on Washington Avenue from Lexington Avenue west is being advocated by the Beverwyck Improvement Association.

BINGHAMTON, N. Y.—A petition is being circulated for the installation of ornamental lamps on Clinton Street, from Oak Street to Jarvis Street.

BROOKLYN, N. Y.—Bids will be received by John J. Dorman, Fire Commissioner, Eleventh Floor, Municipal Building, New York City, until Sept. 28 for construction of a portion of the underground fire-alarm system in the Borough of Brooklyn.

BROOKLYN, N. Y.—Bids will soon be asked by the manager of the Lutheran Hospital, East New York Avenue, for construction of a service building and power house, to cost about $700,000. R. Resler, 41 East Forty-second Street, New York City, is architect.

CLARKSON, N. Y.—The Western New York Utilities Company, Inc., Batavia, has applied for authority to extend its electric plant and lines in Clarkson.

GRANVILLE, N. Y. — Permission has been granted the Eastern New York Electric & Gas Company to extend its electric lighting system in the village of Granville.

HEMPSTEAD, N. Y. — The Nassau & Suffold Lighting Company has applied to the Public Service Commission for permission to build an electric plant and to furnish electricity in the town of Hempstead in the sections known as Island Park, Barnum Island and Oceanside.

ILION, N. Y.—The village of Ilion has been granted authority to extend its electric lines from Ilion to German Flats.

JAMAICA, N. Y.—Bids will be received by the Board of Health of the Department of Health, 505 Pearl Street, New York, until Sept. 29 for furnishing and installing new electric lighting fixtures throughout the new pavilion for the Queensboro Hospital, located on Flushing Avenue, near Union Turnpike, Jamaica. Louis I. Harris, M.D., is president of board.

NEW YORK, N. Y.—Bids will be received by the Commissioner of Purchase of the City of New York, Room 723, Municipal Building, New York City, until Sept. 27 for furnishing incandescent lamps, electrical material and supplies to the Police Department and the Department of Plant and Structures. Peter J. Dooling is commissioner.

NEW YORK, N. Y.—Bids will be received by the office of the General Medical Superintendent, Bellevue Hospital (entrance 415 East Twenty-sixth Street), New York, until Sept. 28 for furnishing all labor and materials required for alterations and repairs to the nurses' home and power house of the Harlem Hospital, located on Lenox Avenue, between 136th and 137th Streets. Bids will also be received at the same time and place for furnishing and installing new fixtures in the two new wings of the new nurses training school, Bellevue Hospital, and also bids for furnishing and installing a complete system of illuminating fixtures for pavilions F and G, Bellevue Hospital. Separate bids to be submitted on each item. John W. Perilli, M.D., is acting president.

ST. GEORGE, N. Y. — An additional 15,000-kw. Westinghouse unit is to be installed in the Livingston plant of the Staten Island Edison Corporation, which serves the borough of Richmond. The cost of the new equipment and reconstruction work is estimated at $1,340,000.

WATERFORD, N. Y.—Permission has been granted the Troy (N. Y.) Gas Company to extend its electric and gas service in the town of Waterford.

WHITE PLAINS, N. Y.—A permit has been issued to the Westchester Lighting Company, Mount Vernon, for the construction of an equipment, service and repair building on Water Street, to cost about $125,000.

EDGEWATER, N. J.—The Kellogg Products Company, 1317 Elk Street, Buffalo, plans to install electric power equipment in its proposed local linseed oil mill, to cost about $200,000.

NEWARK, N. J.—Bids will be received by Charles P. Gillen, Director of Department of Parks and Public Property, City Hall, until Sept. 27, for general construction of a power plant, including plumbing, electrical work, heating and power work, separate bids to be submitted on each item. James S. Pigott, 14 Park Place, Newark, is architect and engineer.

UNION CITY, N. J.—The Hudson County Board of Freeholders has appropriated $72,000 for the installation of a new ornamental lighting system along the Boulevard from Seventh Street to Highwood Terrace, Weehawken.

BATH, PA. — Plans for the proposed local cement mill to be built by the Keystone Portland Cement Company, Commonwealth Building, Allentown, recently organized, to cost about $1,000,000, include a power plant.

PHILADELPHIA, PA.—Bids will be received for the Electrical Bureau, by George W. Elliott, director, Department of Public Service, City Hall, until Sept. 30, for lead-covered cable, wire, junction boxes, fire and patrol posts and fittings, etc., as per specifications on file at room 616, City Hall.

PITTSBURGH, PA. — The Duquesne Light Company has applied for permission to construct and operate a transmission line in a portion of Shaler Township.

WHEELING, W. VA.—Steps have been taken by the Warwood Improvement Association for the installation of ornamental lamps along Warwood Avenue.

RADFORD, VA.—The Appalachian Electric Power Company, Richmond, which has purchased the rights of the New River Development Company, Pearisburg, has applied to the Federal Power Commission for a license covering a development on New River, near Radford. It is proposed to build a dam 110 ft. high and provide a reservoir 19 miles long covering 4,000 acres. The plans provide for the installation of four or five 20,000-hp. units.

WASHINGTON, D. C. — Bids will be received by the Chief of Air Corps, Washington, until Sept. 28, for miscellaneous electrical equipment, including lamp assemblies, switches, control, panel assemblies, etc. (Circular 33).

North Central States

DETROIT, MICH. — The Ford Motor Company, Highland Park, plans extensions in its steam-operated power plant at River Rouge, to cost about $400,000.

CLEVELAND, OHIO.—Bids will be received at the office of the Commissioner of Purchases and Supplies, City Hall, Cleveland, until Oct. 1, for "White Way Lanterns" for the Division of Light and Power.

COLUMBUS, OHIO. — The Columbus Packing Company plans to install electric power equipment in a proposed addition on South High Street, to cost about $200,000.

LANCASTER, OHIO.—Bids will be received until Oct. 5 for the construction of a power house for the Boys' Industrial School, Lancaster, which is under the Ohio Department of Public Welfare, Columbus. J. E. Harper is director of the department. Herman B. Briggs, Hartford-Ohio Building, Columbus, is architect.

REPUBLIC, OHIO.—The Republic Iron & Steel Company, Youngstown, has authorized plans for the electrification of its local works, to cost about $100,000.

HARRODSBURG, KY.—The Board of City Commissioners have voted to sell the municipal electric plant to the Kentucky Hydro-Electric Company, Louisville, which plans extensions and improvements to the system.

BOONVILLE, IND. — Plans are under way by the Boonville Electric Light & Power Company for extensions and improvements, to cost about $75,000, to include a 2,000-kw. General Electric turbine.

EAST MOLINE, ILL.—The Peoples Power Company, a subsidiary of the United Light & Power Company, 733 Illinois Merchants Bank Building, Chicago, plans to rebuild its substation in East Moline, and to erect over the Mississippi River from the Riverside plant two 13,200-volt circuits, connecting the new station at Moline with the central station east of Davenport. New switching arrangements will be provided at the East Moline plant to take care of the outgoing circuits of 13,200 and 4,800

volts. The cost is estimated at $200,000. A large part of the equipment has been purchased.

SHEBOYGAN, WIS.—The Northern Furniture Company plans to install electric power equipment in a proposed addition, to cost about $175,000.

ROCHESTER, MINN.—Work will soon begin on the construction of a power plant for the Kahler Hotel Corporation and the Mayo Clinic, to cost about $350,000. Ellerbe & Company, 692 Endicott Building, St. Paul, are architects and engineers.

CORRECTIONVILLE, IOWA.—Contract has been awarded by the Northwestern Light & Power Company, Cedar Rapids, for an addition to its local power plant. Two new engines of 600 hp. each will be installed. The cost is estimated at $65,000.

DELHI, IOWA.—The Interstate Power Company, 327 South La Salle Street, Chicago, has plans for the construction of a hydro-electric power plant in this vicinity, to cost about $450,000. Transmission lines will be extended.

LIDDERDALE, IOWA.—The Iowa Light, Heat & Power Company, Carroll, which has acquired the municipal electric plant, contemplates the extensions in transmission line in this vicinity for local service.

KEYTESVILLE, MO.—The installation of a new ornamental lighting system is under consideration by the City Council.

MARYVILLE, MO.—Bids will be received by the City Council until Sept. 28 for an electrically-driven triplex pump capable of delivering 500 gallons per minute against a maximum head of 400 ft.

PURCELL, MO. — The Empire District Electric Company, Joplin, has authorized the erection of a 6,600-volt transmission line to Purcell and vicinity.

ST. LOUIS, MO.—The Union Electric Light & Power Company has applied for a certificate of convenience and necessity to erect and operate a transmission line in Madison County.

ST. LOUIS, MO.—Electric power equipment will be installed in the proposed municipal service building to be erected at Clark Avenue and Twelfth Street, by the Board of Public Service at a cost of about $1,000,000. The plans include an electrical equipment repair division. Study & Farrar, Arcade Building, are architects.

ROLLA, N. D.—The installation of an ornamental lighting system on Main Street is under consideration.

HASTINGS, NEB.—Bids will be received by William S. Watson, chief engineer of the Water and Light Department, until Sept. 27 for extensions and alterations to the municipal water and electric plant. R. A. Bradley & Company, Hastings, are architects.

O'NEILL, NEB.—The Tri-State Utilities Company, Minneapolis, Minn., is erecting a number of transmissions in northwestern Nebraska for the purpose of unifying service and providing a larger pool of stand-by power. The project includes a 66,000-volt line across the counties of Cedar, Knox and Holt, from Wynot to O'Neill, 90 miles long; a 33,000-volt line from Butte to a connection across the South Dakota line, and a 13,200-volt line from Creighton to Brunswick.

Southern States

CHARLOTTE, N. C.—The Southern Fruit Company, South College Street, plans to install electric power equipment in a proposed local cold storage and refrigerating plant, to cost about $135,000.

ALBANY, GA.—The City Commissioners are considering calling an election to authorize $187,000 in bonds for municipal improvements, including the installation of additional street lamps, to cost about $35,000; rebuilding present electric lines, $5,000, and installation of traffic lights, $5,000.

FOLKSTON, GA. — The Ware County Light & Power Company, Waycross, has applied for a franchise to build a power plant in Folkston to furnish electric service.

SAVANNAH, GA.—The Savannah Electric & Power Company plans to rebuild its power plant, recently damaged by fire with loss of about $100,000.

VALDOSTA, GA.—Extensions and improvements to the street-lighting system is contemplated by the Valdosta Lighting Company.

FLAGLER BEACH, FLA.—The Florida Power & Light Company, Miami, which has been granted a franchise here, plans to acquire the local electric plant.

GAINESVILLE, FLA.—Bids will be received by the City Council until Sept. 28 for furnishing and installing pipe, electrically-operated crane, pump, heater and tank for the municipal light and water plant. G. H. Cairns is city manager. Robert & Company, Inc., Bona Allen Building, Atlanta, Ga., is architect and engineer.

HOMESTEAD, FLA.—Plans are under way by the city officials for the installation of an ornamental lighting system along Flagler and Campbell Streets and Krome Avenue, covering a distance of 10,500 feet.

JACKSONVILLE, FLA.—The City Council is considering calling a special election to submit the proposal to issue $2,000,000 in bonds for extensions to the municipal electric light and power plant.

MIAMI, FLA.—Extensions and improvements have been authorized by the Florida Power & Light Company as follows: In the Miami district, including Miami Beach, Coral Gables, Fulford, Hialeah, Ojus and Larkins, to cost $215,000; additional extensions at Palatka, $11,040; reconstruction of distribution system in Cleveland, also a new line from the Punta Gorda plant to Cleveland, $11,490; for installation of a boiler feed pump at Bradenton; for erection of transmission line, installing equipment, etc., at St. Augustine, $73,230; for extension of electric distribution system in Sarasota, $10,960; and in Golden Gate subdivision at Stuart, $33,450, and for improvements at West Palm Beach, $38,475.

NEW PORT RICHEY, FLA.—The City Council contemplates the installation of an ornamental lighting system in the downtown district, including West Main Street.

OCALA, FLA.—Plans are under way by the Florida Power & Light Company for the construction of a local substation, and power switching station, to cost about $65,000.

ST. AUGUSTINE, FLA.—The installation of an ornamental lighting system is under consideration by the City Council.

JOHNSON CITY, TENN.—The Tennessee Eastern Electric Company has applied to the Federal Power Commission for another preliminary permit for five dams on the Holstein River, its South Fork and Watauga River, involving the development, respectively, of approximately 100,000 hp., 60,000 hp., 25,000 hp., 25,000 hp. and 30,000 hp., or a total of 240,000 hp.

TREZEVANT, TENN.—Plans have been approved by the Mayor and Board of Aldermen for the construction of a electric power plant and distribution system in Trezevant by the Kentucky-Tennessee Power & Light Company, Bowling Green, Ky. The company proposes to extend its high-tension lines from McKenzie to supply service here.

MOSS POINT, MISS.—Plans are being prepared by the Mississippi Power Company, Gulfport, for the erection of a transmission line from Moss Point to Bay St. Louis, about 55 miles.

DELIGHT, ARK.—Negotiations are under way between the village officials and the Dierks (Ark.) Lumber & Coal Company relative to the latter extending its transmission line from Murfreesboro to Delight to furnish electrical service here.

BASTROP, LA.—The Louisiana Power & Light Company, Slertington, has purchased the municipal electric power plant, and plans extensions in transmission lines in this section.

ELTON, LA. — The Louisiana Electric Company, Lake Charles, which has acquired the local electric light and ice plants, proposes to erect a high-tension transmission line to furnish electrical service here.

PATTERSON, LA. — The Gulf Public Service Company, a subsidiary of the General Public Utilities Company, 1,600 Walnut Street, Philadelphia, is rebuilding the local plant and plans to furnish service in Patterson, Berwick and Jeanerette.

ASHER, OKLA.—Plans have been prepared for the installation of an electric distribution system in Asher and a transmission line from Asher to Wanette, to cost about $28,000. The Gantt-Baker Company, 1116 West Main Street, Oklahoma City, is engineer.

CHICKASHA, OKLA.—Plans are under way by the Chickasha Gas & Electric Company for the erection of a 13,200-volt transmission line from Chickasha to Gracemont, via Anadarko, a distance of 35 miles, to cost about $60,000. The Byllesby Engineering Company, 231 South La Salle Street, Chicago, is in charge of the work.

ELK CITY, OKLA.—The Southwestern Light & Power Company, which is erecting 141 miles of new electric transmission line connecting the local power stations and Quanah, Texas, with the high-tensions transmission lines recently acquired from the Inland Utilities Company extending from Hobart and Elk City, is planning to erect a 10,000-kw. substation here.

McLOUD, OKLA.—The Oklahoma Gas & Electric Company, Oklahoma City, which has secured a local franchise, plans extensions in transmission lines in this section.

SAYRE, OKLA.—Plans are being prepared by the Southern Light & Power Company, Oklahoma City, for the erection of a 33,000-volt transmission line from Elk City to Sayre, a distance of 16 miles, at a cost of about $40,000.

BROWNSVILLE, TEX.—The City Council is considering calling an election to vote on the proposal to issue $100,000 in bonds for extensions to the municipal electric plant, including the installation of a turbine and extension of distribution system.

COMFORT, TEX.—The Central Power Company has acquired the local electric plant and ice factory and plans extensions and improvements to same.

CORPUS CHRISTI, TEX.—Plans have been authorized by the Texas Central Power & Light Company, San Antonio, for a new substation. Transmission lines will be extended, and voltage increased from 23,000 to 36,000 volts.

FREDERICKSBURG, TEX.—The Texas Central Power & Light Company, San Antonio, which has purchased the local electric plant and plans extensions and improvements to the system, to cost about $35,000.

SAN ANTONIO, TEX.—An addition of 100 miles of power transmission lines to its system in south Texas is contemplated by the Central Power & Light Company. The project includes a line from Nordheim to Kenedy, one from Eagle Lake to Columbus and Schulenburg, and one from Gonzales to Luling. Surveys are being made for transmission lines between Crystal City, Catarina and Cotulla, and from Catarina to Laredo. During the next year the company plans to erect several hundred miles of transmission lines to its south Texas connections, all of them to be linked up by means of the interconnections at Saspamco and Spanish Pass, the intervening line belonging to the San Antonio Public Service Company.

Pacific and Mountain States

ZILLAH, WASH.—The Yakima (Wash.) Fruit Growers' Association, plans to install electric power equipment in its proposed local cold storage and refrigerating plant, to cost about $175,000.

BAKER, ORE.—Plans have been prepared by the Eastern Oregon Light & Power Company for the construction of an addition to its local steam-operated electric generating plant, to cost about $50,000.

ALHAMBRA, CAL.—The City Council has authorized the installation of ornamental lamps on Curtis and Olive Avenues, Seventh, Eighth and Ninth Streets, from Valley Boulevard to Hellman Avenue, and portions of Romona Boulevard and Hellman Avenue.

BEVERLY HILLS, CAL. — The City Council has authorized the installation of ornamental lamps on Wilshire Boulevard, across the city, requiring 239 cast iron standards.

LOMA LINDA, CAL.—Plans for the formation of a proposed lighting district are under consideration by the Board of Supervisors.

LONG BEACH, CAL.—Preliminary plans are being prepared by the H. D. Frankfort Company, 1096 North Western Avenue, Los Angeles, for the Medical Research Institute, including two research laboratories, college hospital, and administration buildings, two ten-story apartments, two dormitories, two gymnasiums, swimming pool, two large garages, power plant, laundry, two warehouses and fifty-four dwelling houses, connecting tunnels between all buildings, etc., near Long Beach. The cost is estimated at $25,000,000.

LOS ANGELES, CAL.—The Zellerbach Paper Company plans to install electric power equipment at its proposed mill in the Southgate district, to cost about $400,000.

LOS ANGELES, CAL.—The installation of ornamental street lamps on portions of La Jolla Avenue, Rampart Boulevard and other streets, to cost about $25,000, is under consideration.

LOS ANGELES, CAL.—The City Council has adopted a resolution providing for the installation of ornamental lamps on First Street, from San Pedro to Main Streets, using pressed steel standards.

MONROVIA, CAL.—The City Council has adopted a resolution, providing for the installation of ornamental lamps on Maple Avenue, using concrete standards.

ONTARIO, CAL.—Plans are under way by the City Council for the installation of ornamental lamps on Euclid Avenue, and other thoroughfares, requiring in all 362 concrete standards.

SAN DIEGO, CAL.—The City Council is considering a petition for the installation of ornamental lamps on portions of Voltaire Street and Ocean Beach Boulevard, between Abbott and Froud Streets, using concrete standards.

SAN FERNANDO, CAL.—The City Council is considering the installation of ornamental lamps on Celis and neighboring streets, using concrete standards, to cost about $12,000.

SAN FRANCISCO, CAL.—The State Railroad Commission has granted the Sierra & San Francisco Power Company and the Pacific Gas & Electric Company, lessee, permission to enlarge the Spring Gap power plant of the former on the South Fork of the Stanislaus River, at a cost of $1,000,000.

SAN FRANCISCO, CAL.—The American River Water & Power Company has applied for permission to appropriate water from the north fork of the American River, Placer County, for a proposed hydro-electric power development, to cost about $1,000,000. The plans include a power dam, 30 ft. high and 80 ft. long.

TURLOCK, CAL.—Plans are being prepared by the Turlock Irrigation District for a power development to have a capacity of 27,000 hp., at a cost of about $5,000,000. R. V. Meikle is chief engineer.

PUEBLO, COL.—The Atchison, Topeka & Santa Fe Railway Company, Chicago, plans to install electric power equipment in proposed additions to local repair shops, including new car shop and machine and repair shop, to cost $350,000. H. A. Tice, Pueblo, is division superintendent.

ALAMOGORDO, N. M.—Parties are negotiating for the local municipal electric light and power plant, headed by G. M. Einhart, Roswell, are considering the construction of a large central power station in this section, with transmission lines to Tularosa, La Luz and neighboring districts.

Canada

PRINCE GEORGE, B. C.—The McArthur Sawmill Company plans to install electric power equipment in a proposed new group of mills, to cost about $400,000.

ROSSLAND, B. C.—The West Kootenay Power & Light Company, Ltd., plans to build a hydro-electric plant on the Kootenay River, near Lower Bonnington, with initial capacity of 60,000 hp. A transmission line will be built to serve the plant of the Consolidated Mining & Smelting Company and other industries. The cost of the entire project is estimated at $3,000,000.

VANCOUVER, B. C.—The installation of an ornamental lighting system, to cost about $46,250, has been authorized by the City Council.

QUEBEC, QUE.—The erection of six new electric transmission lines has recently been authorized by the Public Service Commission as follows: To the Brompton Pulp & Paper Company for the construction of a 50,000-volt line to connect its mills with the system of the Continental Heat & Light Company, Shawinigan Falls; the Southern Canada Power Company, Montreal, for the erection of a transmission line between Waterloo and Warden and a line in the village of Warden; to the Electric Service Corporation, Shawinigan Falls, a transmission line between Chaudiere and St. Jean Deschaillons and a line between Scott and St. Antoine de Lotbiniere; to the St. Francis Water & Power Company, Thetford Mines, a 27,000-volt line between St. Evariste and Lambton, and a line between Montee St. Michel and Ste. Edouard de Napierville.

Electrical Patents

Announced by U. S. Patent Office

(Issued Aug. 31, 1926)

1,598,192. MOTOR-CONTROL SYSTEM; C. L. Seymour, Babylon, N. Y. App. filed Sept. 15, 1921. For governing the operation of planers, drill presses and other machine tools. A machine tool with a control system that shall so govern an alternating-current motor by means of impedance elements inserted in the secondary circuit as to limit the current during starting, to gradually accelerate the motor to full speed, and to effect substantially short-circuit conditions in the secondary circuit when the motor is operating at normal speed.

1,598,218. STORAGE BATTERY; O. W. Oetting, East Cleveland, Ohio. App. filed May 12, 1922. Small type, for radio use.

1,598,236. METHOD OF BUILDING AND STARTING ELECTRIC INDUCTION FURNACES; C. A. Brayton, Jr., Cleveland, Ohio. App. filed Sept. 24, 1920.

1,598,268. ELECTRIC PROPULSION OF SHIPS AND OTHER VEHICLES; M. de Cininck, Le Havre, France. App. filed June 8, 1920. In which the transmission of energy from the prime movers to the propellers is effected by means of polyphase alternating currents.

1,598,312. ELECTRIC SWITCH; A. R. Rice, Toronto, Ontario, Canada. App. filed May 14, 1924. Pull chain socket.

1,598,315. SUBMARINE SOUND RECEIVER; C. P. Ryan, Droxford, England. App. filed Feb. 27, 1924.

1,598,393. ELECTRICAL DRIVE FOR CREAM SEPARATORS; C. A. Robertson, Springfield, Ill. App. filed Nov. 14, 1921. Of the centrifugal type.

1,598,406. PROTECTION OF ELECTRICAL APPARATUS FROM OVERLOADS; H. Tinsley, Leeds, and J. H. Cox, Outwood, England. App. filed Feb. 12, 1926. Means are provided whereby, at starting, the trip or cut-out mechanism is not permitted to act upon the usual initial rush of current and the support or platform carrying one element of the overload cut-out solenoid and plunger mechanism is moved from the starting to the normal running position through a resilient connection and under the influence of a delay action device, such as a dashpot, which determines the time taken for the said movement. In the starting position the plunger is sufficiently out of the solenoid to require an excess of current greater than the usual sudden starting current to produce a field in the solenoid sufficiently strong to move the plunger while, in the normal running position, the plunger is in a more favorable position for action by the solenoid field and can be operated by a current exceeding the normal full load by any predetermined smaller amount.

1,598,452. METHOD OF MANUFACTURING UNIFORMLY LOADED CONDUCTORS; E. Schürer, Cologne-Mulheim, Germany. App. filed Aug. 13, 1925.

1,598,459. ELECTRICAL CONNECTOR; G. B. Thomas, Bridgeport, Conn. App. filed March 11, 1925. As used on appliances.

(Issued Sept. 7, 1926)

16,417 (reissue). ELECTRIC LEVEL INDICATOR; G. E. Henderson (deceased), late of Near Manton, Cal. App. filed Sept. 26, 1912. Means for electrically indicating at a distant point the height of level of water in a reservoir or ditch, or the pressure of steam or other fluid or other similar conditions.

1,598,595. RECORDING METER; D. J. Angus, Indianapolis, Ind. App. filed March 19, 1926. Of the automatic double-speed type. The change from low speed to high speed is effected not only in minimum time so that the chart will be moving at the high speed very early in the first second of the emergency, but without possibility of interrupting the high-speed drive and destroying the high-speed record until the desired predetermined movement at high-speed has been accomplished.

1,598,632. ELECTRIC IGNITER; C. Wimmer, Jr., and K. Schnaooer, Wurtemberg, Germany. App. filed Sept. 3, 1921. By means of which even wood-staves of considerable thickness may be rapidly and surely ignited by applying thereto the arc produced between two electrodes of suitable material, such as carbon.

1,598,639. ELECTRIC CONTROLLER; W. C. Briggs, Ashbourne, Pa. App. filed Jan. 12, 1923. Reversing switch, especially adapted for use in connection with motors commonly employed on hoists, cranes and like machinery.

1,598,666. SYMMETRICAL ROTATING SWITCH; L. J. Voorhees, Binghamton, N. Y. App. filed Dec. 9, 1921. For use on flashlights.

1,598,683. PROTECTED METALLIC ELECTRODE; G. W. Heise, Bayside, N. Y. App. filed May 19, 1924. Particularly applicable in cells of the metal-caustic alkali-depolarizing oxide type.

1,598,696. CANOPY HOLDER; J. B. Bander, New York, N. Y. App. filed June 19, 1925.

1,598,731. CLEANING OF METAL BY ELECTROLYSIS; I. H. Lee, Detroit, Mich. App. filed May 1, 1925. Wherein the articles to be cleaned are placed in an electrolyte through which an electric current is passed.

1,598,749. SWITCHING APPARATUS; W. M. Scott, Tredyffrin Township, Chester County, Pa. App. filed Feb. 17, 1923. Inclosed type circuit breaker. The switch or circuit breaker structure may be manually tripped from the exterior of the housing by a member sliding upon or through the actuating mechanism without movement of the actuating mechanism with or in the direction of the tripping member.

1,598,753. ELECTRIC HEATER; E. W. Spackman, Indianapolis, Ind. App. filed March 23, 1925. For heating and circulating air by an electrically heated element. An electric element in a form adapted for use in either a portable stove, a fixed stove or a furnace of the full circulating air type.

1,598,804. WEIGHT-OPERATED CIRCUIT CLOSER; N. L. Brumbach, Eldorado, Kan. App. filed Aug. 4, 1922. Electrically operated means, including a horn or a bell for warning a person passing a building such as a garage or small alley, to indicate that an automobile is about to pass out of the opening of same.

1,598,833. ELECTRIC ALARM CLOCK; B. Viola, Detroit, Mich. App. filed March 22, 1926. An apparatus that may be attached to any existing alarm clock that will be actuated thereby to turn on the lights, start up the furnace, or produce other similar effects when the alarm mechanism operates.

1,598,834. THREADED CLAMP CONNECTOR FOR STORAGE BATTERIES; H. E. Walker, Chicago, Ill. App. filed Aug. 6, 1921.

1,598,862. ELECTROMEDICAL APPARATUS; K. P. Hangl, New York, N. Y. App. filed Oct. 27, 1923. Apparatus for the production of low-frequency currents for application to the human body.

1,598,874. ELECTRICAL APPARATUS; L. A. Phelan, Beloit, Wis. App. filed Jan. 19, 1922. Contact-making device, for commercial use, wherein the conducting terminals or electrodes, at which the electrical contact-making and breaking operations are effected, are enclosed in a container which also contains a compact and coherent body of current-conducting fluid, through the agency of which the said electrodes are brought into electrical conducting relation with one another.

1,598,875. ELECTRICAL APPARATUS; L. A. Phelan and C. Hotchkiss, Beloit, Wis. App. filed Nov. 24, 1922. Contact-making device comprising spaced electrodes that are sealed into a closed container and are brought into contact by means of a movable conducting fluid.

1,598,876, 1,598,877. ELECTRICAL APPARATUS; L. A. Phelan and P. K. Cramblet, Beloit, Wis. App. filed Dec. 22, 1922. Contact-making device comprising spaced electrodes that are sealed into a closed container and are brought into contact by means of a movable conducting fluid.

1,598,950. GROUNDING DEVICE FOR ELECTRIC CURRENT; F. Wilcox, Green Bay, Wis. App. filed May 8, 1925. A device which is intended to be placed upon a cable while it is being installed, the device being constructed to promptly short circuit and ground current accidentally passed through the cable.

1,598,984. COVER FOR ELECTRIC OUTLET BOXES; J. T. Pearson and R. H. Olley, Syracuse, N. Y. App. filed Sept. 27, 1922.

1,598,997. PORTABLE ELECTRIC STAND LAMP; A. Wild, Brooklyn, N. Y. App. filed Sept. 16, 1925.

1,599,056. ELECTRODE FOR WELDING AND LIKE PURPOSES; H. D. Lloyd and C. E. Hill, Warrington, England. App. filed Nov. 12, 1923. An improved or modified flux coating composition for a welding electrode.

1,599,061. DRY BATTERY OF BATTERY WITH A SOLIDIFIED ELECTROLYTE; R. Oppenheim, Lavallois-Perret, France. App. filed Feb. 17, 1925.

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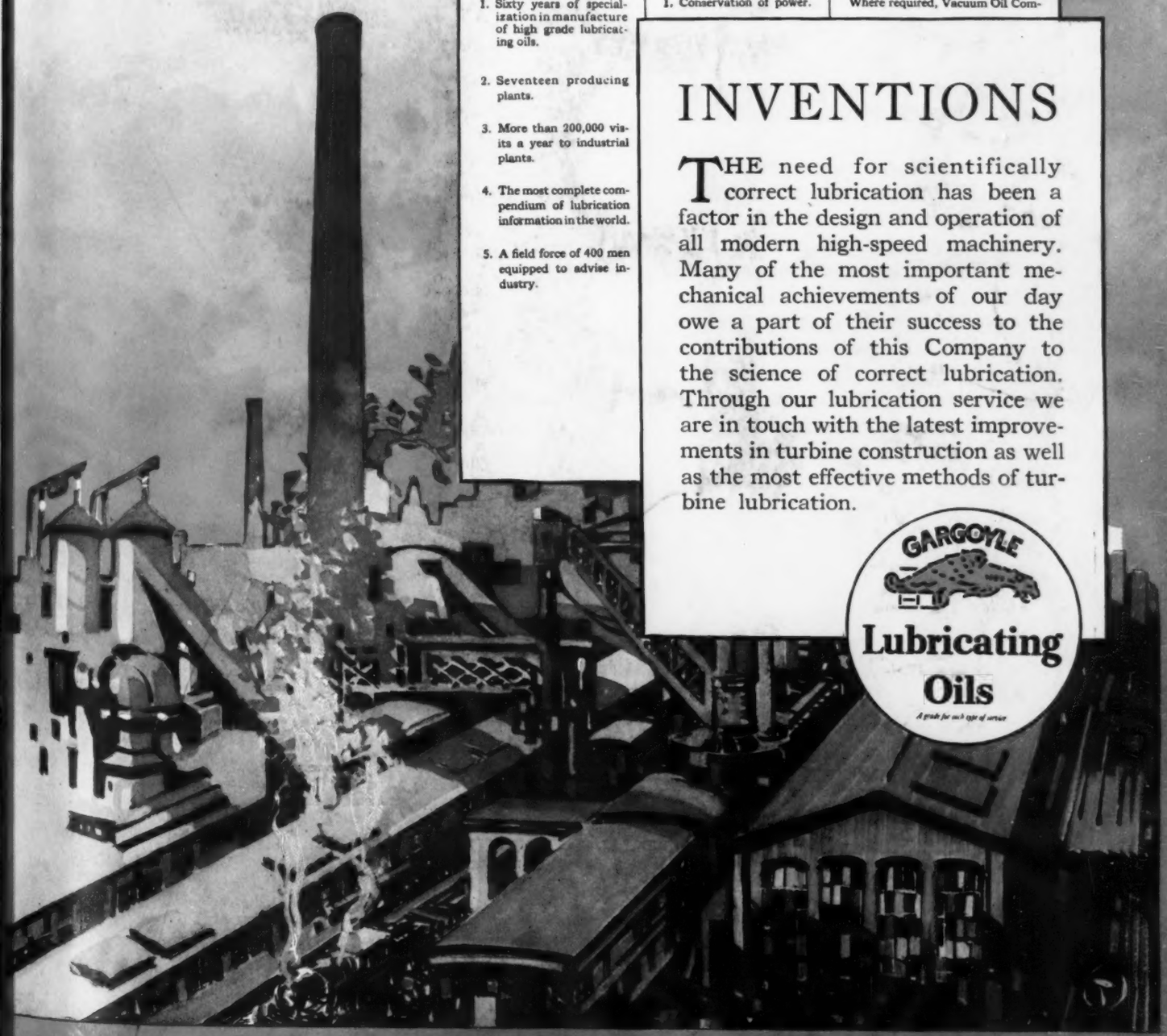

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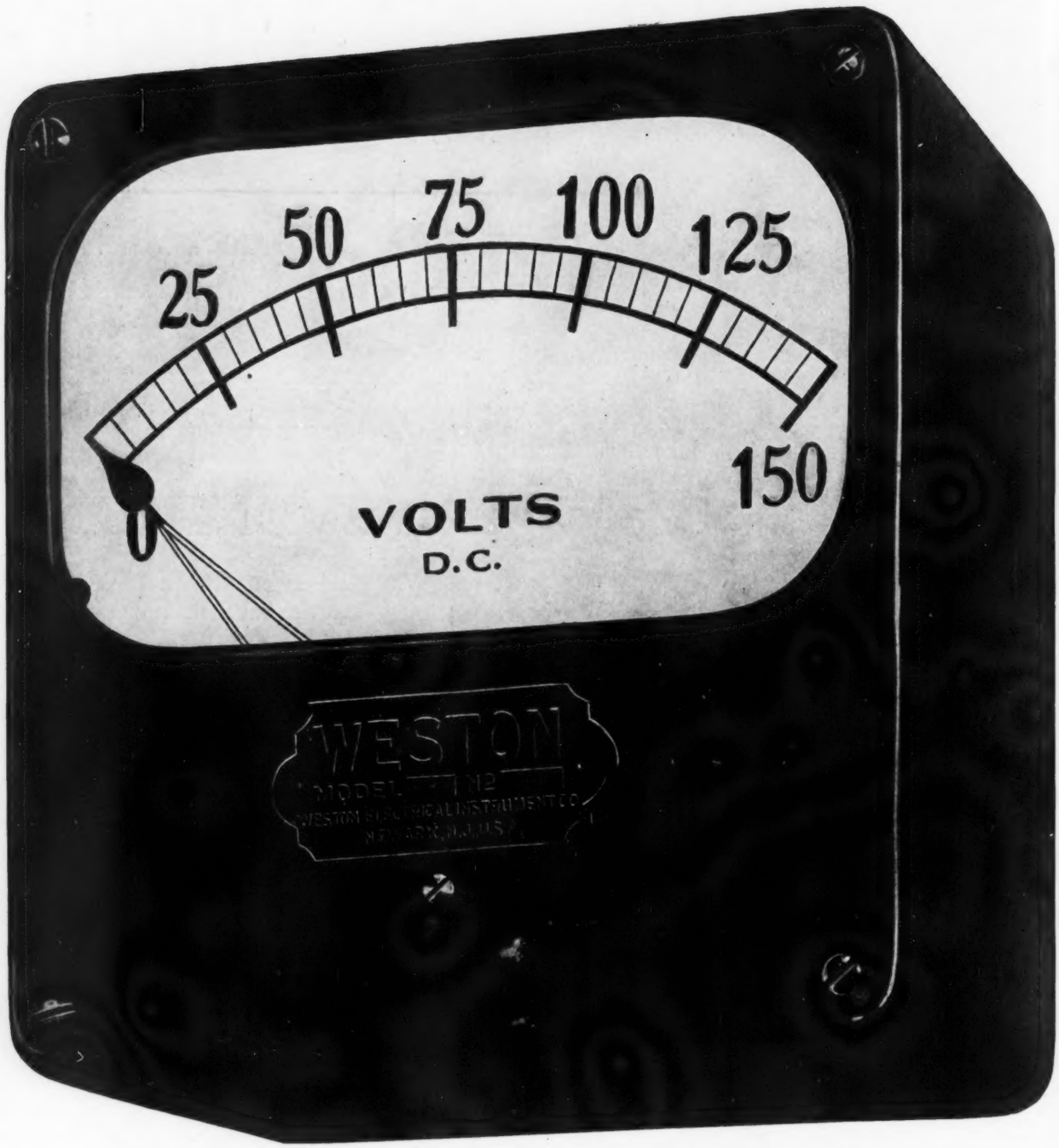

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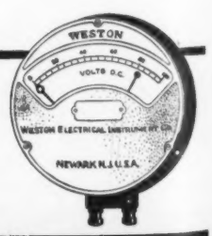

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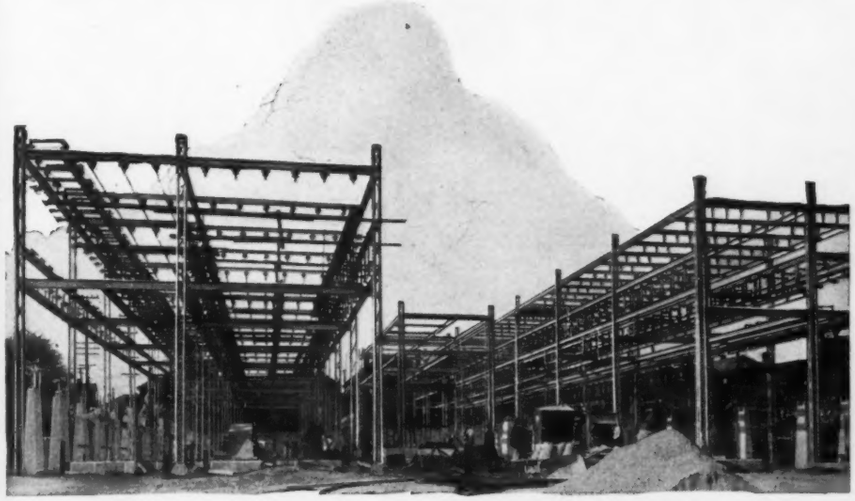

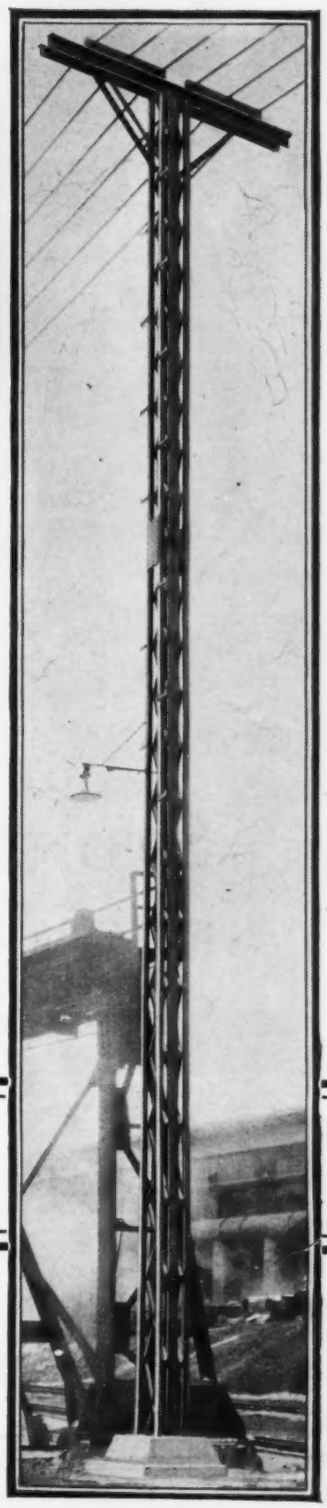

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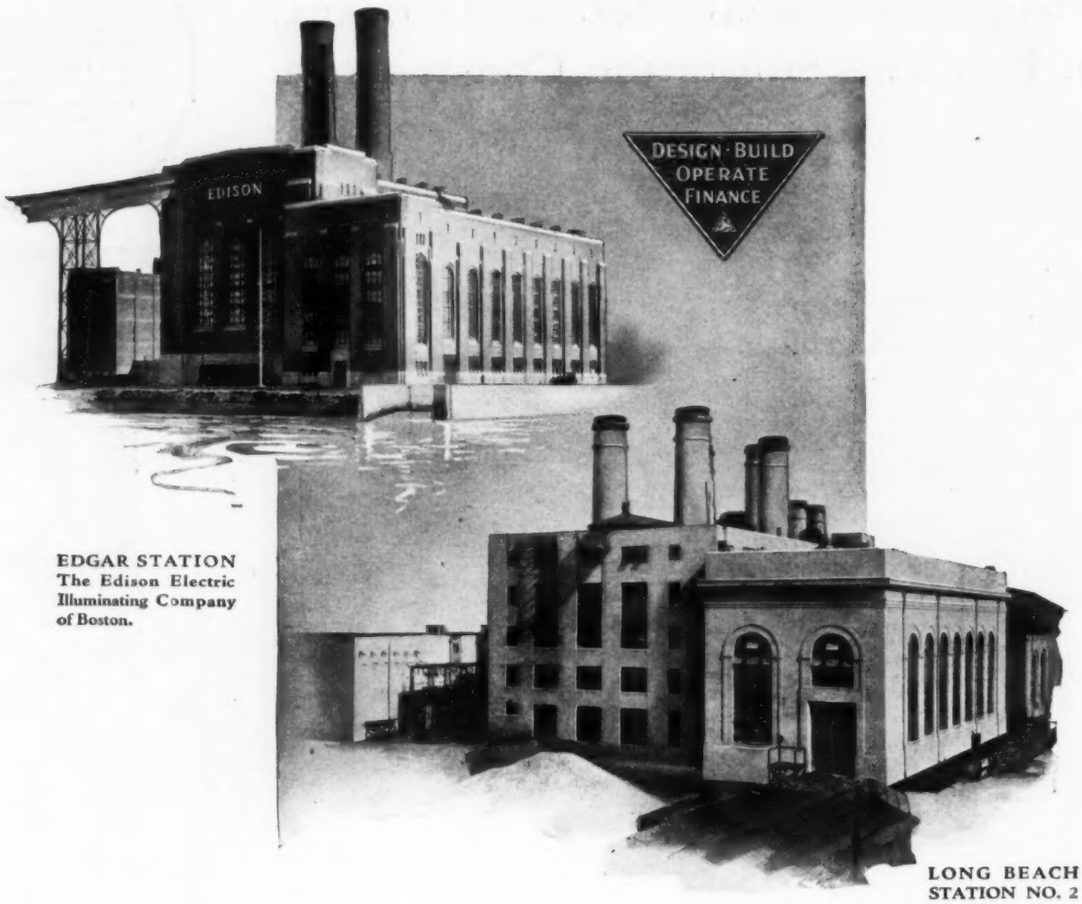

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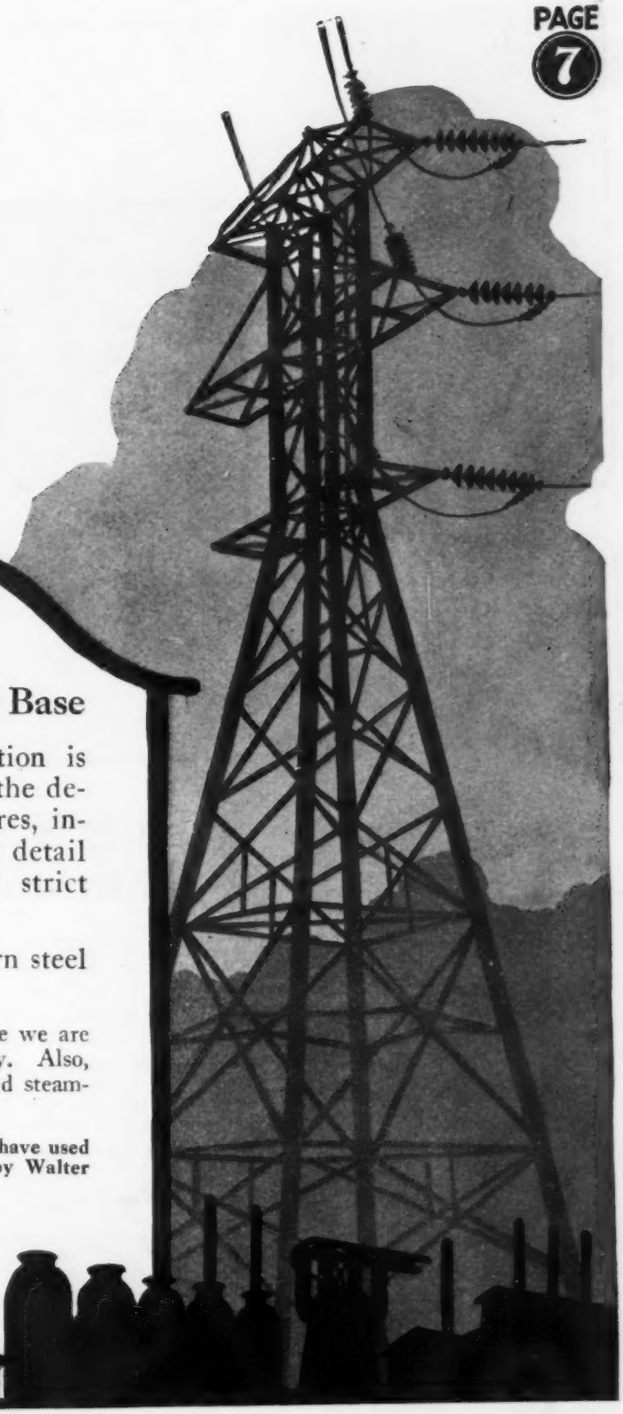

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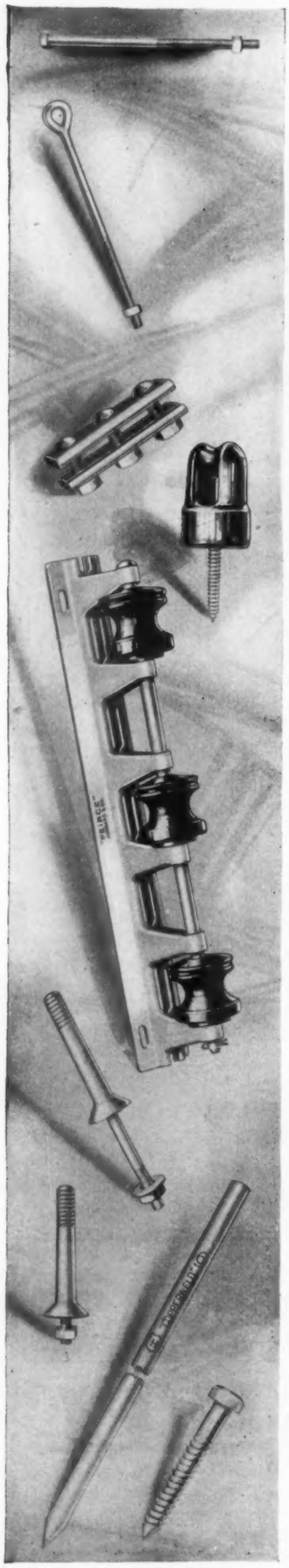

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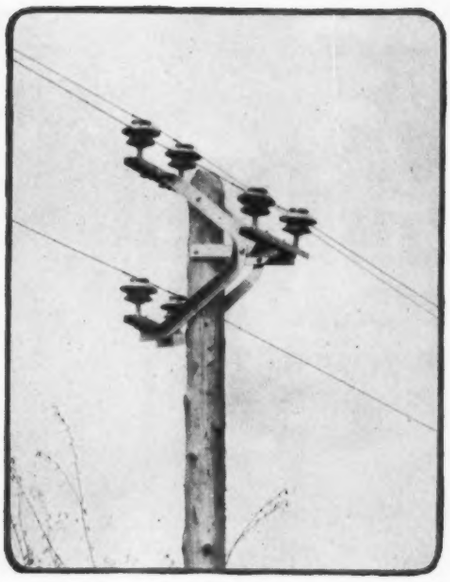

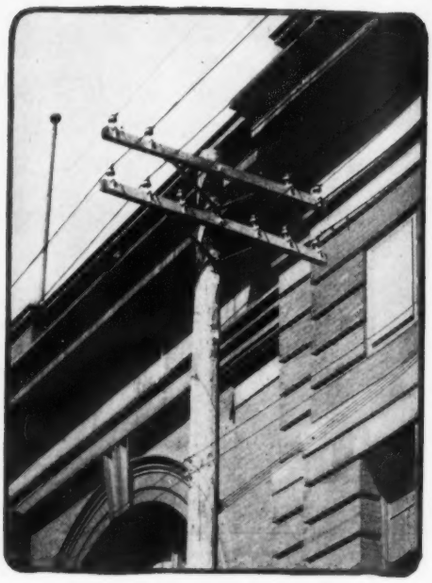

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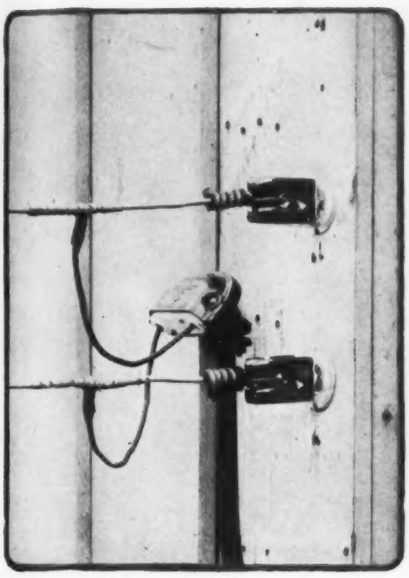

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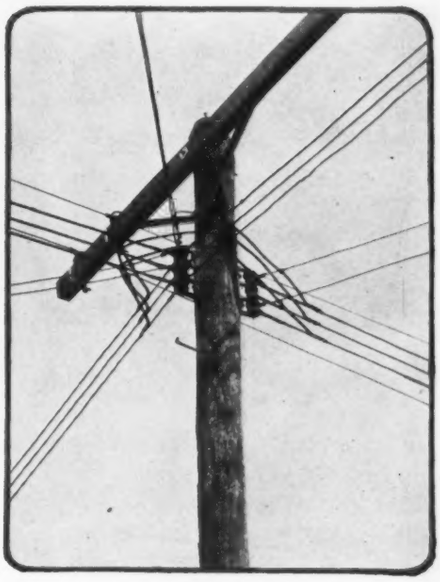

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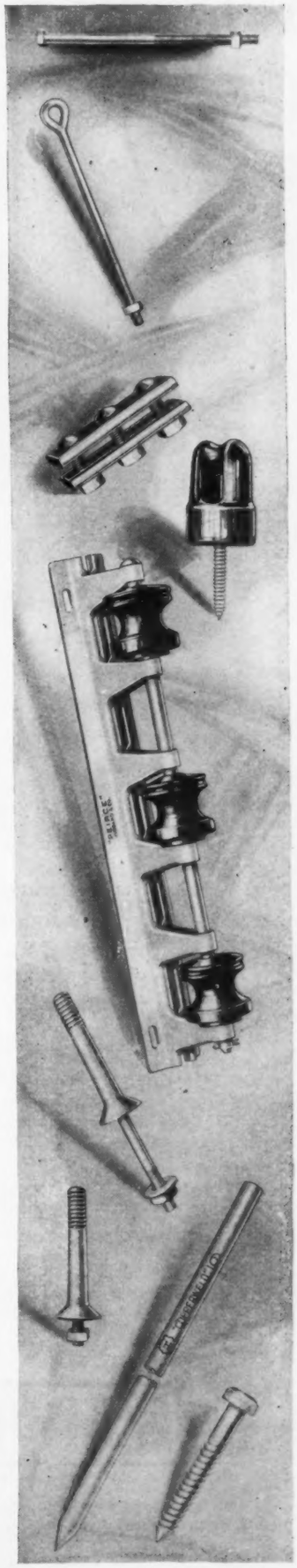

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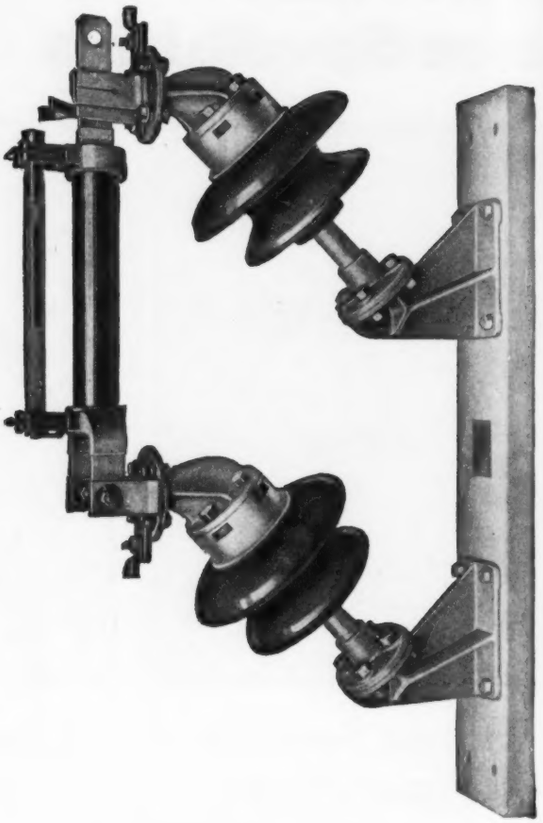

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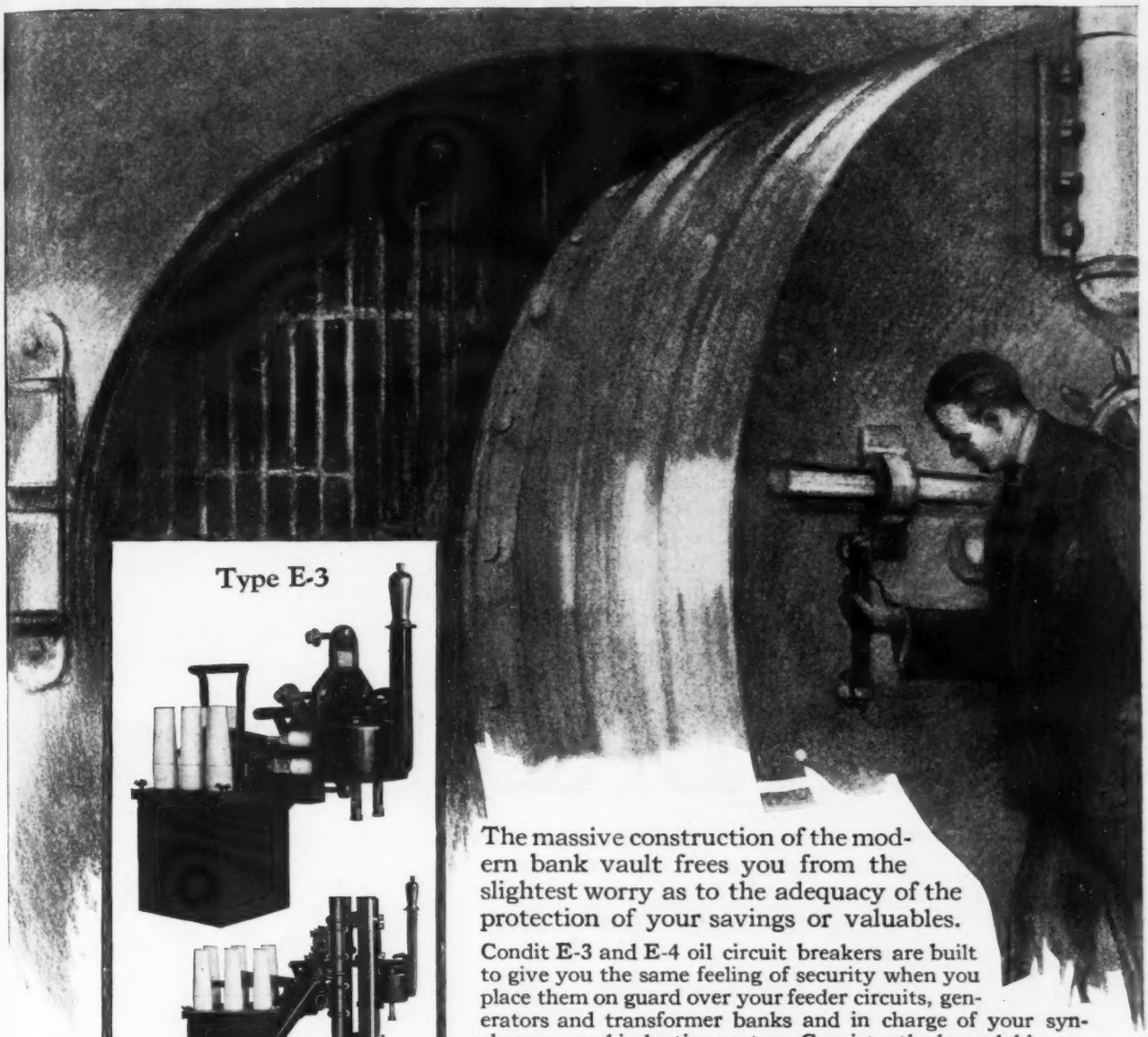
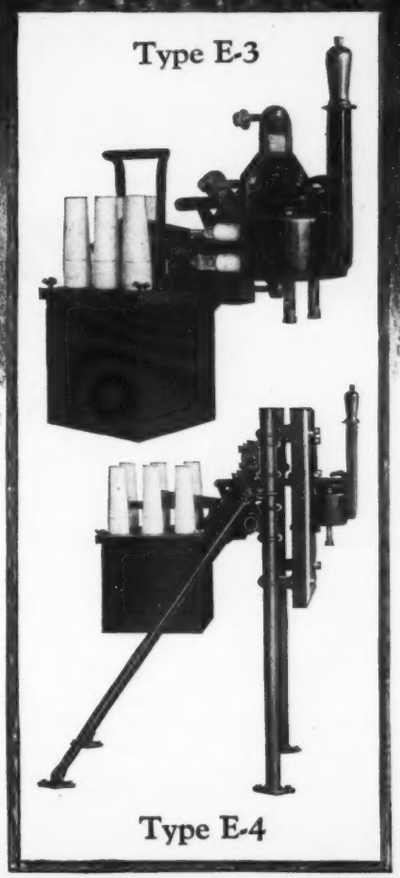
PROTECTED





The massive construction of the modern bank vault frees you from the slightest worry as to the adequacy of the protection of your savings or valuables.

Condit E-3 and E-4 oil circuit breakers are built to give you the same feeling of security when you place them on guard over your feeder circuits, generators and transformer banks and in charge of your synchronous and induction motors. Consistently dependable performance entitles them to your complete confidence.

"*Get in touch with Condit*"

CONDIT ELECTRICAL MFG. CORP.

Manufacturers of Electrical Protective Devices

Boston, Mass.

Northern Electric Company
LIMITED

Sole Distributor for the Dominion of Canada

SPECIFICATIONS: *Standard Ampere Capacities, Type E-3 at 4500 volts, or less; Type E-4 at 7500 volts, or less. Interrupting Capacity (per phase) Type E-3, 2700 amperes at 2500 volts; Type E-4, 5100 amperes at 2500 volts.*

8472

CONDIT

Oil Purification

Is an essential part of transformer maintenance routine. The gradual assimilation of moisture and solid impurities in the insulating oil is a fact that must be recognized and means taken to prevent the consequent damage from breakdowns.

Formerly, the purification and dehydration of transformer oil was a tedious, laborious and expensive process, entailing the withdrawal from service of the transformer concerned for anywhere from 10 to 48 hours. Likewise, results to be obtained from the apparatus employed were not always satisfactory or sure.

All that is history now, for with the development of the Hydroil, came the means for complete, and constant purification of transformer oil, *without taking the transformers out of service.* The Hydroil method contemplates permanently connecting the purifier to the transformer tanks, and circulating the oil through it whenever routine tests show a falling off in dielectric strength.

The HYDROIL *alone*

—has *double chamber and double outlets.* A *drying chamber* and a *separate chamber for the water.*

—has means to deliver a *constant flow* of clean, dry oil, testing *above 22 kilovolts,* regardless of the proportion of incoming water and oil.

—has such *large dry oil capacity.*

—has such *low operating cost.*

The HYDROIL is a self-contained machine, designed for the exclusive purpose of drying and cleaning insulating oil. Results are obtained through its exclusive features which no other apparatus for the purpose will produce.

The development of the HYDROIL has created a new standard of quality for insulating oil. A continuous process with the dielectric strength of the oil above 22 kv. *when and as dehydrated.* The last gallon is as dry as the first.

The HYDROIL wet and dry tank system will care for all transformers, circuit breakers, electrolytic arresters and feeder regulators within twenty-five miles of station.

Permanent installations equipped with HYDROIL Separator and our wet and dry storage tanks.

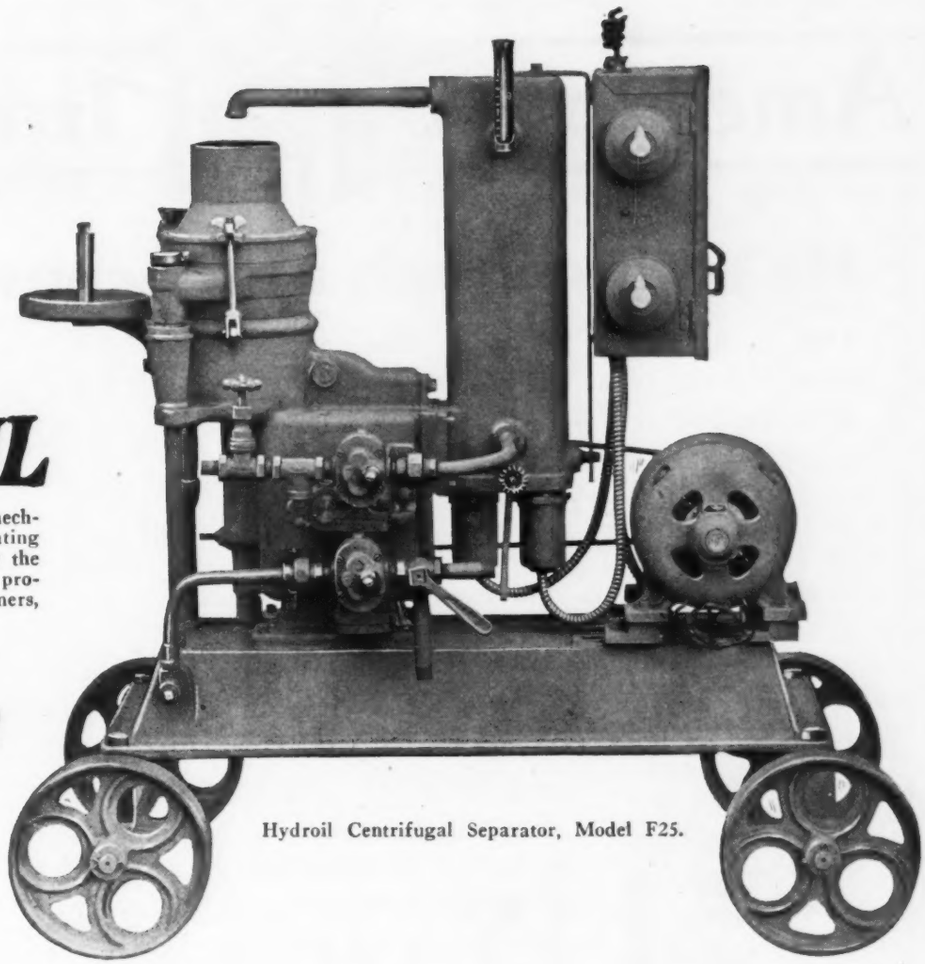
For complete information and prices, send your request to our nearest sales office.

Hydroil
SALES CORPORATION
LEBANON, INDIANA

This is the HYDROIL

The ultimate development of a mechanism for continuously dehydrating and purifying transformer oil by the operation of which every power producer or consumer using transformers, is assured of

Absolute Sure



Hydroil Centrifugal Separator, Model F25.

PROTECTION

against Transformer Damage due to lowered dielectric strength of oil

Regardless of the proportions of oil and water in the mixture entering the HYDROIL, a perfect and continuous separation is effected. The HYDROIL will deliver a *continuous* stream of dehydrated and purified oil with a maintained dielectric strength over 25,000 volts.

No free water is discharged with oil.

The patented and exclusive HYDROIL Bowl with its perforated water wall, maintains a constant separation between the extracted water and the purified oil. Water and oil are discharged in the same proportions as they enter the HYDROIL. No necessity to stop the HYDROIL until all the oil is treated. Oil so purified is reconditioned and made highly resistant to emulsification.

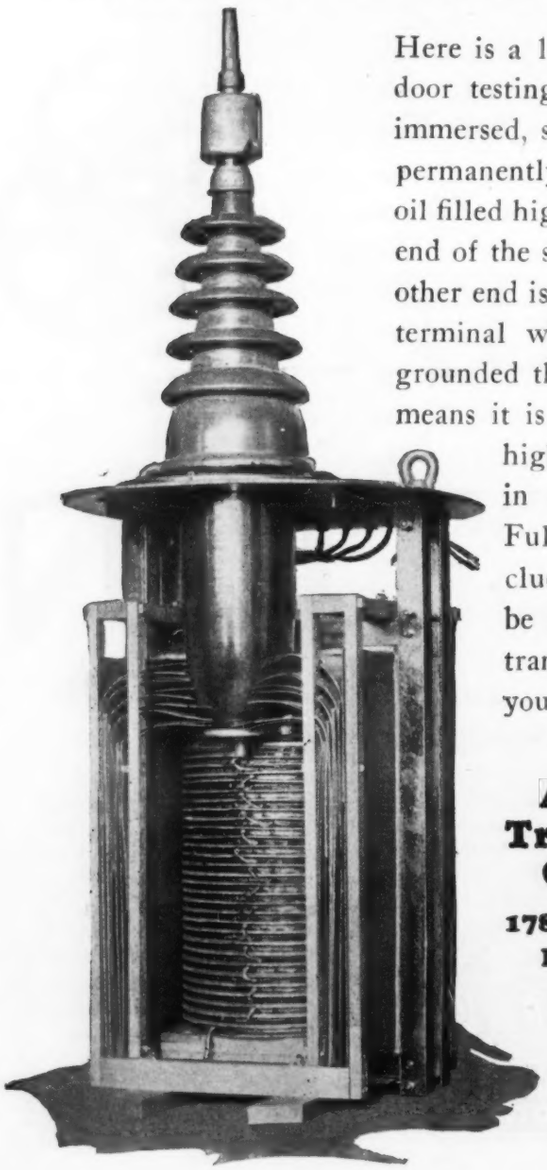
Hydroil
SALES CORPORATION
LEBANON, INDIANA

American Transformer

Make thorough and accurate tests

That is the way to progress. Testing helps to build better utilities. Leading engineers and leading companies know this. And they are solving many problems by making tests regularly.

For these tests many central stations, electrical manufacturers and experimental laboratories are using American Transformers. These companies know by experience that they can get special equipment, designed correctly and built quickly with which they can get accurate results. And results count. Consult with us.



Here is a 150,000 volt, 60 cycle indoor testing transformer. It is oil immersed, self cooled, with one end permanently grounded. It has an oil filled high tension bushing on one end of the secondary winding. The other end is brought to a low tension terminal which is arranged to be grounded through a meter. By this means it is possible to measure the high tension current in the secondary. Full information, including prices, will be gladly given on transformers to meet your specifications.

American Transformer Company
178 Emmett Street
Newark, N. J.

Ask a User

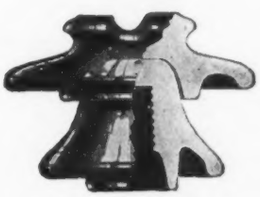
No. 1111

THERE are two really good ways of determining the actual worth of insulators.....*One,* is to put them on your lines, and *watch* them. If they last for the required period of years, the case is proven — the insulators are good. But, that takes time. Something better will probably be out by that time. So here's your alternative....*Ask some user* if it's a fact that the new "Thomas Quality" pin type insulators are *so unfailingly dependable.* Ask him if they show any signs of *deterioration* on his lines, or if they successfully withstand the *power-arc.* Question him as to the ruggedness of these new designs and if they will stand the "ups and downs" of *rough handling*....If these new designs are not what they should be, the user will tell you; it's human nature. *You would do as much for him,* in a reverse case.

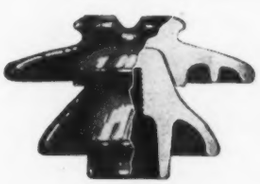
No. 1009

No. 2120

No. 1188


No. 2117

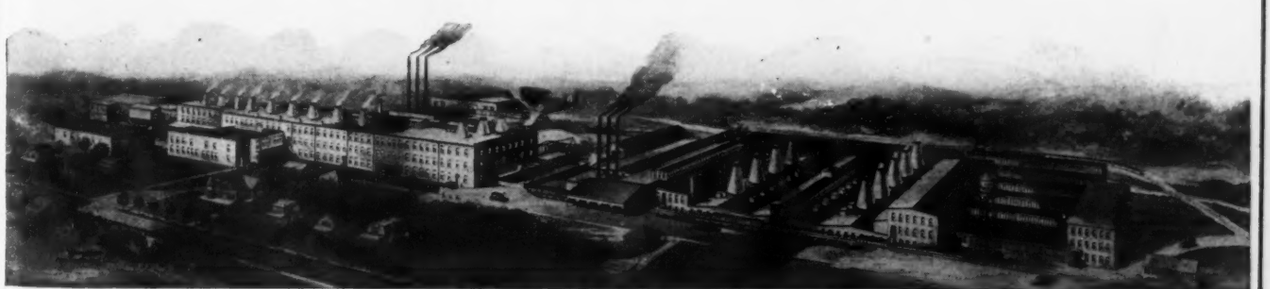
No. 1178-9


No. 2124

Just let us know what design you are interested in and we will advise the name of the nearest user. Then you can conduct your own investigation.

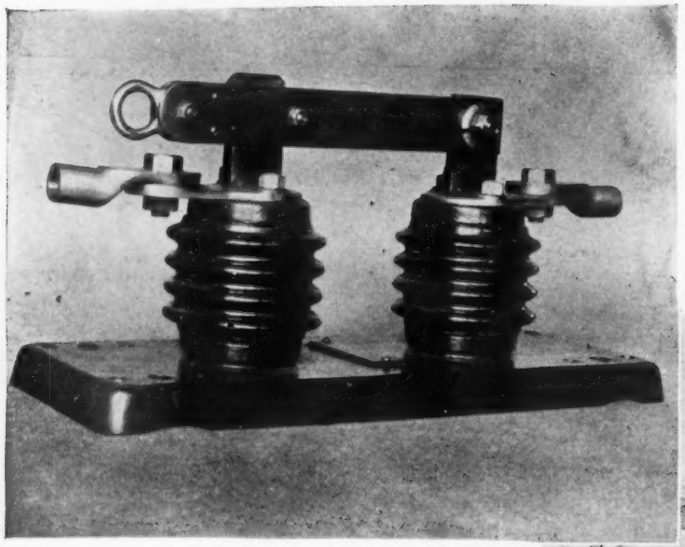
No. 1157-8

THE R. THOMAS & SONS CO.
EAST LIVERPOOL, OHIO
NEW YORK BOSTON CHICAGO LONDON
Graybar Electric Co. on Pacific Coast Northern Electric Co. in Canada

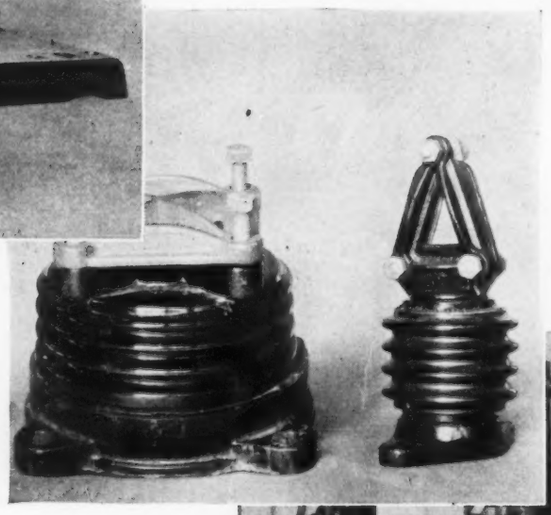


E L P

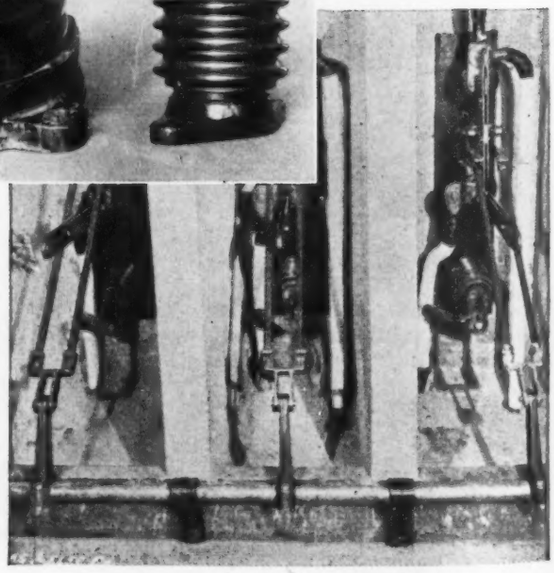
Noteworthy Central Station in the Power Plants—



Elpeco Indoor Disconnects mean Safety



Elpeco Bus Supports Rugged and Dependable



Elpeco Pothead and Grounding Switch

for the good of the Service

ELPEC

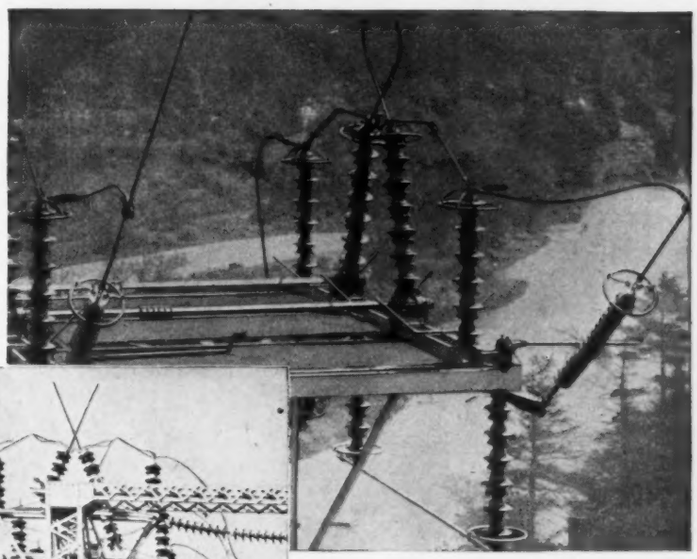
ELECTRIC POWER EQUIPMENT CORPORATION

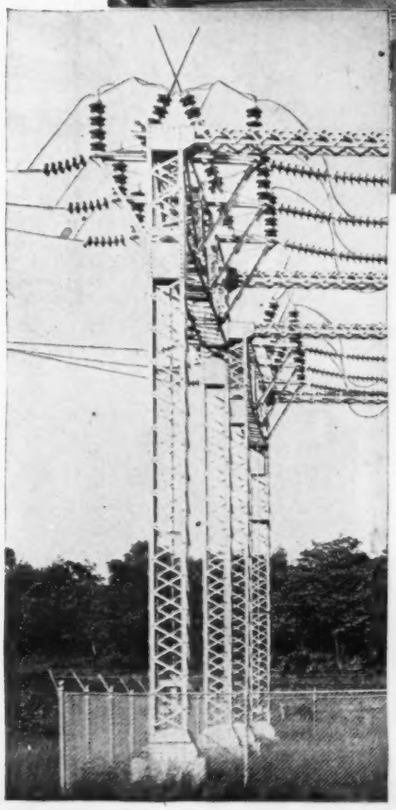
412-420 NORTH EIGHTEENTH ST. PHILADELPHIA, PA.

E C O

advances in Construction

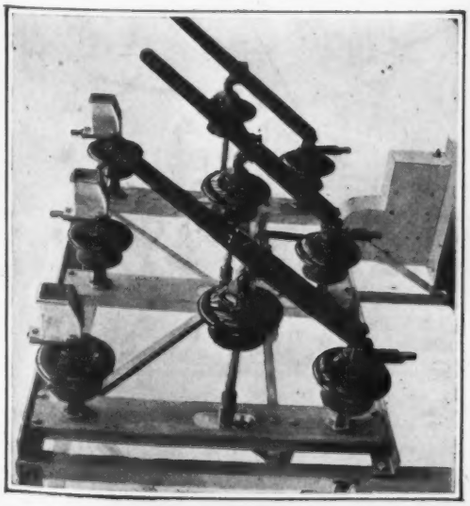
for the Substation and Line—





Highest Voltage Elpeco Horn Gap Switches 220 KV. also from 11 KV. up

Elpeco Motor or Manual operated gang switches



Elpeco Switches as applied to outdoor substation

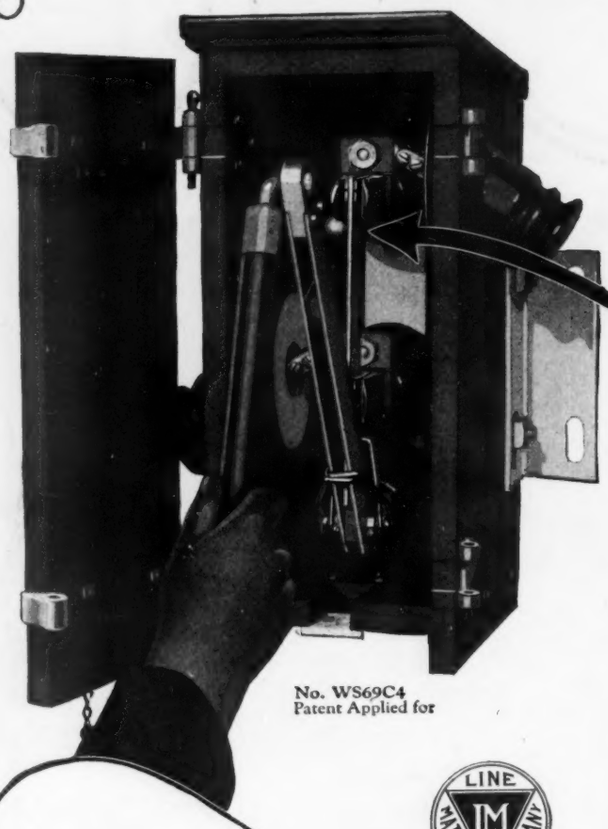
for the good of the Service

ELPEC

ELECTRIC POWER EQUIPMENT CORPORATION

412-420 NORTH EIGHTEENTH ST. PHILADELPHIA, PA.

Quick-Break Primary Disconnect



No. WS69C4
Patent Applied for

QUICK
— BREAK-BLADE —

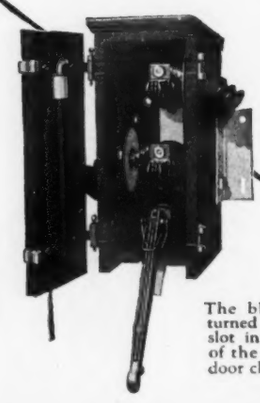
The Quick-Break-Blade remains in the contact clips until the regular blade is pulled four inches from the upper contact. The brass wire spring provides a cam action at the hinge end and accelerates the motion of the Quick-Break-Blade. Copper guides are placed on the regular blades so that the Quick-Break-Blade cannot possibly get out of place.

THE Quick-Break-Blade is hinged on a third insulator so that when the switch is opened the switch-blade is absolutely dead.

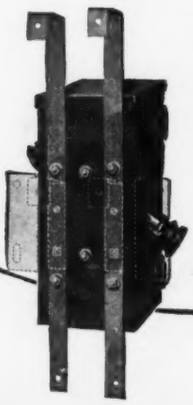
Special designed brown glazed porcelain bushings are inserted thru the sides of housing carrying wire direct to terminal lugs. Standard lugs have three binding posts to accomodate up to 000 wire, but can be furnished larger if specified.

LINE MATERIAL COMPANY

This Primary Disconnect is enclosed in a well seasoned wooden box when used on circuits of 6600 volts and under.



The blade can be turned down thru a slot in the bottom of the box and the door closed.

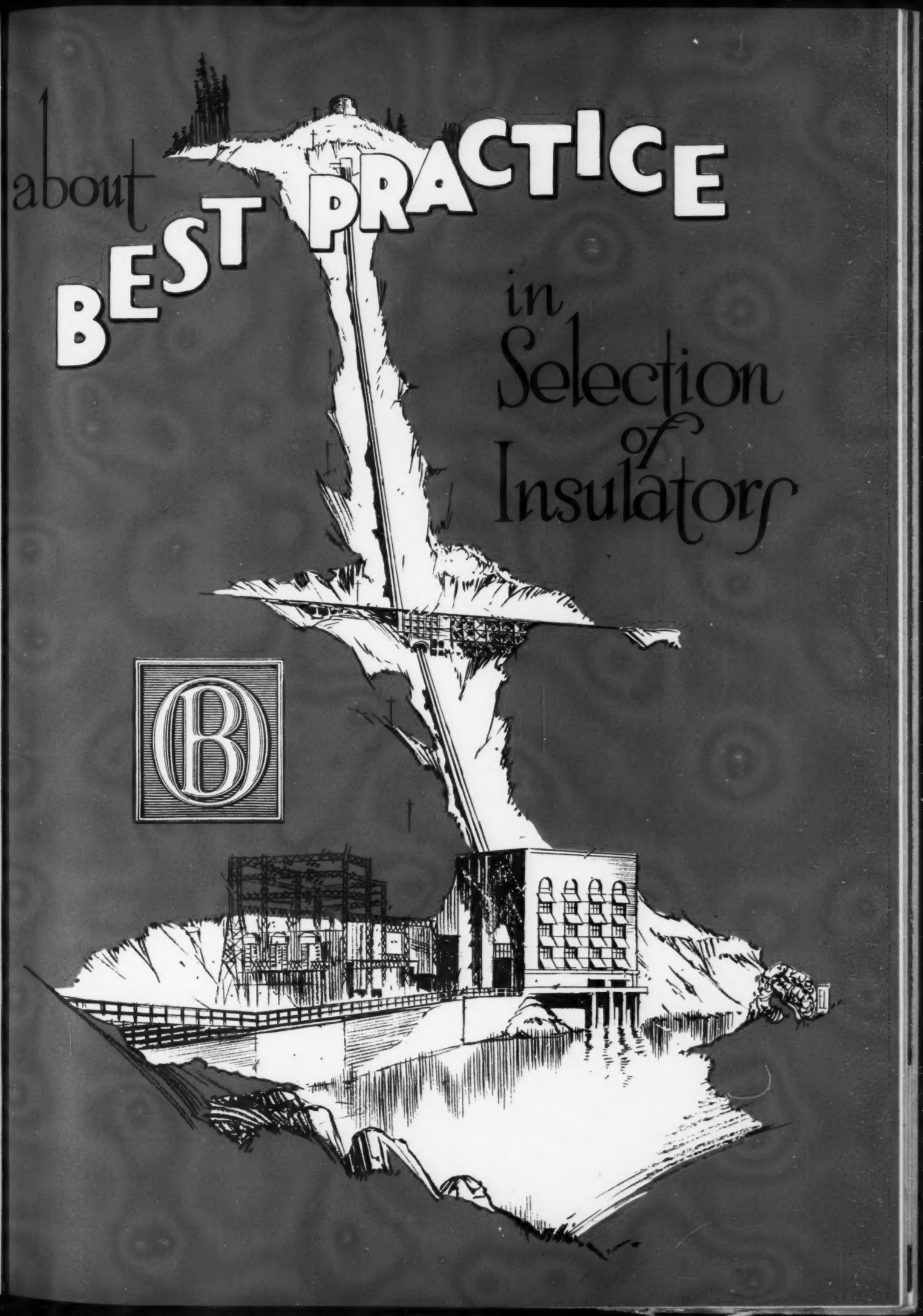


The box can be furnished with three different types of mounting as shown.

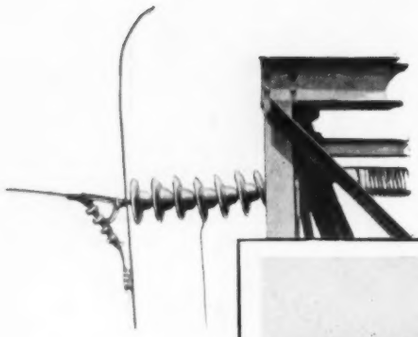
LINE MATERIAL CO.
SOUTH MILWAUKEE, WIS.

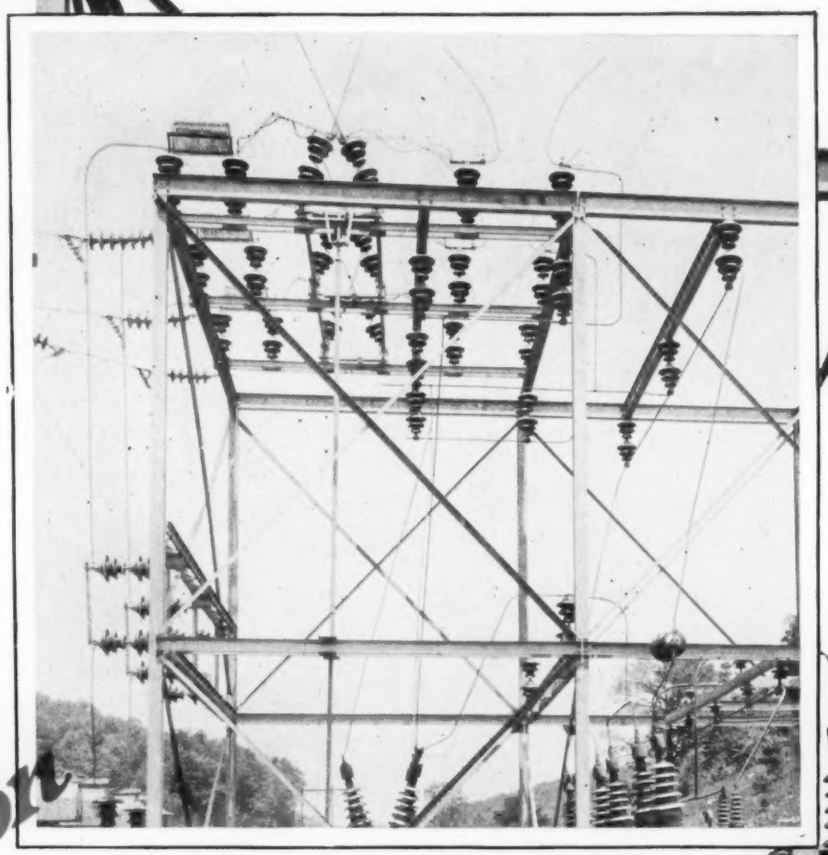
SALES OFFICES AND WAREHOUSE—Branch Plant—East Stroudsburg, Pa.

Albany, N. Y. Chicago, Ill. Des Moines, Iowa Kansas City, Mo. Oakland, Cal.
Allentown, Pa. Cleveland, Ohio Indianapolis, Ind. New York, N. Y. Portland, Ore.
Boston, Mass. Dallas, Texas In Canada—Canadian Line Material Ltd., Toronto, Canada No. Charlotte, N.C. Los Angeles, Cal.


about BEST PRACTICE
in Selection of Insulators

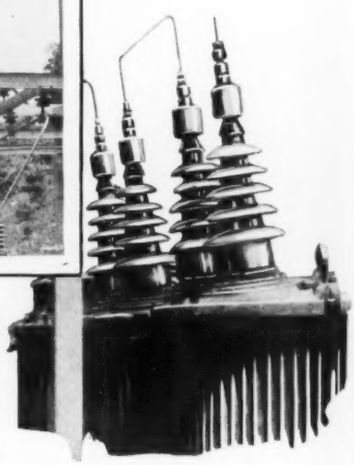
What is Best





Substation Southern Ohio Electric Co. at Superior, Ohio. O-B insulated.

On sub-station



O-B HAS one predominant idea as to what is "best practice" in selecting insulators. It has been repeatedly expressed to users. It has been proved in years of experience with insulators out on the lines, and now we feel that it has been more than justified.

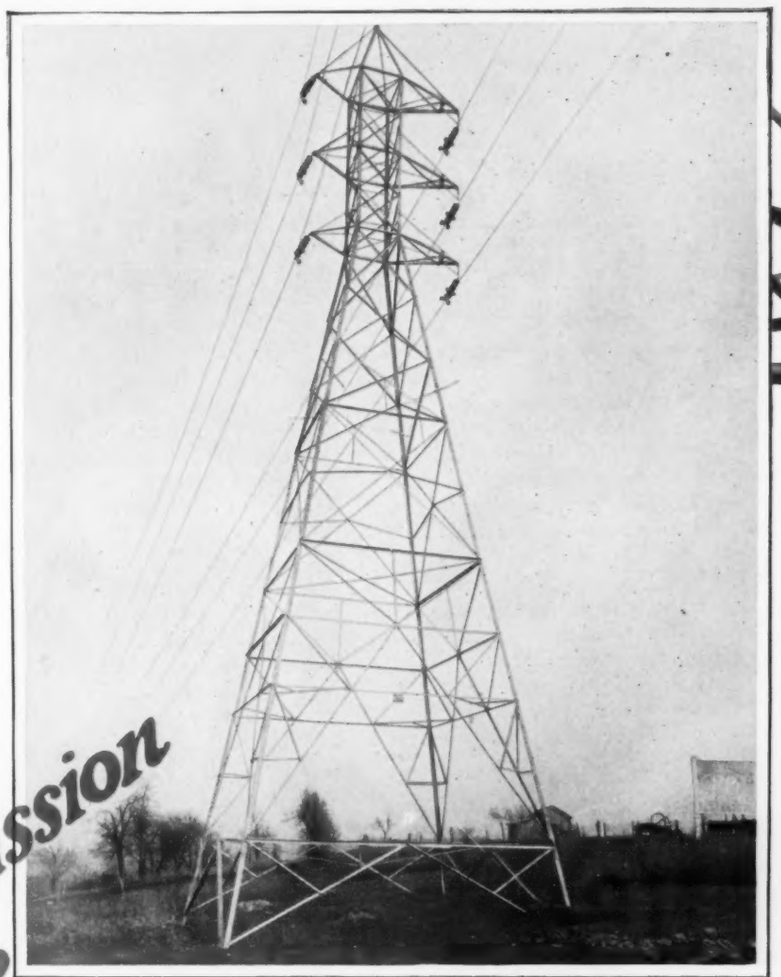
In expressing it to you, therefore, theory may be discarded. Based on experience we are sincerely in earnest when we say that we believe it is the best way for you to buy insulators.

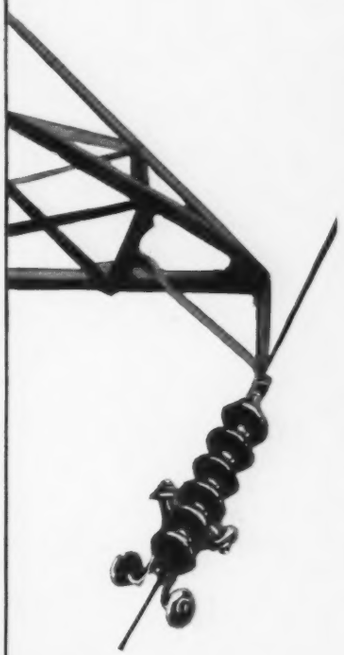
What is this belief—this best practice?

It is that the only way to judge the prospective life of an insulator is to determine its past performance —to find out what its record of life in service is.

HISTORY TELLS WHICH LINE EXCELS

Insulator Practice?





Tower on new Fort Miami line of Union Gas & Electric Co., Cincinnati. O-B insulators and flux control.

On Transmission Line

Certain types of tests are informative and worth while—but only as a check on uniformity and manufacturing methods. But tests cannot tell the story of prospective life of insulators up on the line.

There is a destructive action produced by the combined effect of mechanical load, vibration, thermal stresses and time, the results of which cannot be foretold from laboratory tests.

So we say, test and check for those things that may be safely judged in that manner, but for assurance of longest, interruption-free life out on the line, let past performance be your guide in selecting insulators.

HISTORY TELLS WHICH LINE EXCELS

The Treated Sanded Surface and Long Life

MOST utility managements, genuinely interested in giving the public the best possible service, want insulators that will give longest life and lowest number of power interruptions.

Insulators that depreciate rapidly after a couple of years on the line are really prohibitively expensive, even if cheap in first cost and even if adjustment is made by the manufacturer, because—

It is very expensive to replace insulators.

It is very expensive to have service interruptions.

The greatest single cause of insulator failures is cracked porcelain due to internal stresses. These are set up by the effects of weathering. They must be relieved by inherent properties of the insulator design. The Treated Sanded Surface, which has been applied to some 20 million O-B insulators, is the feature largely responsible for their exceptional freedom from cracking.

The Treated Sanded Surface is a part of the cemented joint between the pieces of porcelain in multipart insulators, or between porcelain and metal in suspension and switch insulators. It introduces a resiliency which provides for the internal stresses imposed by mechanical strains in the assembled unit, or by internal stresses developed from thermal causes.

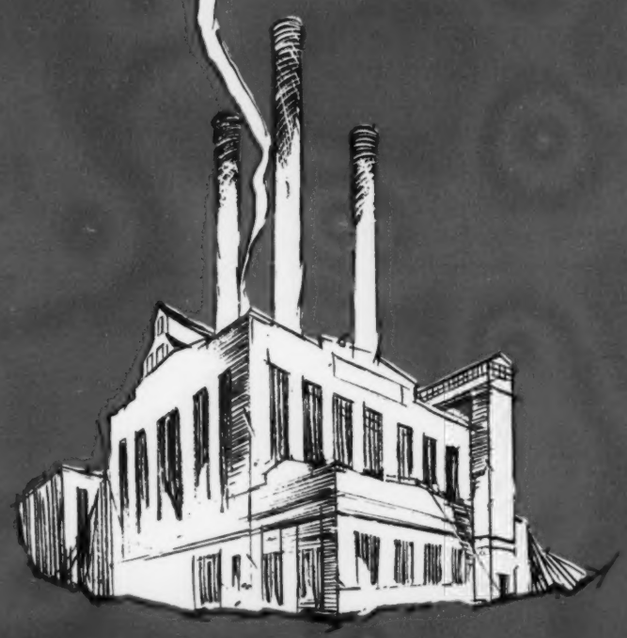
Whatever insulators you buy, be sure they have the Treated Sanded Surface feature.

Ohio Brass Company, Mansfield, O.

Dominion Insulator & Mfg. Co., Limited
Niagara Falls, Canada
198H

Ohio Brass Co.

PORCELAIN INSULATORS
LINE MATERIALS
RAIL BONDS
CAR EQUIPMENT
MINING MATERIALS
VALVES



AMCRECO

CREOSOTED SOUTHERN YELLOW PINE POLES

RESIST INSECTS AND BIRDS

The same impregnation of pure creosoted oil which preserves poles from decay provides ideal protection against the attacks of termites, birds, etc. It insures long life and low annual cost.

AMERICAN CREOSOTING COMPANY

INCORPORATED

COLONIAL CREOSOTING COMPANY INCORPORATED

AMCREO LOWRY PROCESS CREOSOTED WOOD

GEORGIA CREOSOTING COMPANY INCORPORATED

LOUISVILLE ~ KENTUCKY

SALES OFFICES

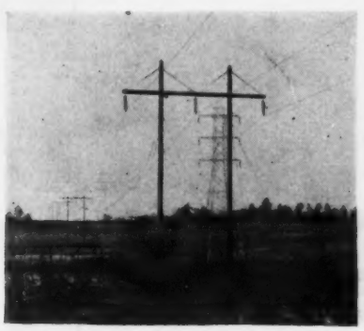
332 So. Michigan Ave. Chicago

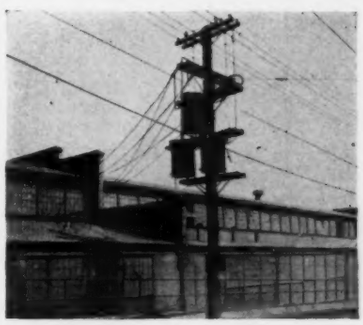
350 Madison Ave. New York City

Brunswick, Ga.

401 W. Main St. Louisville, Ky.

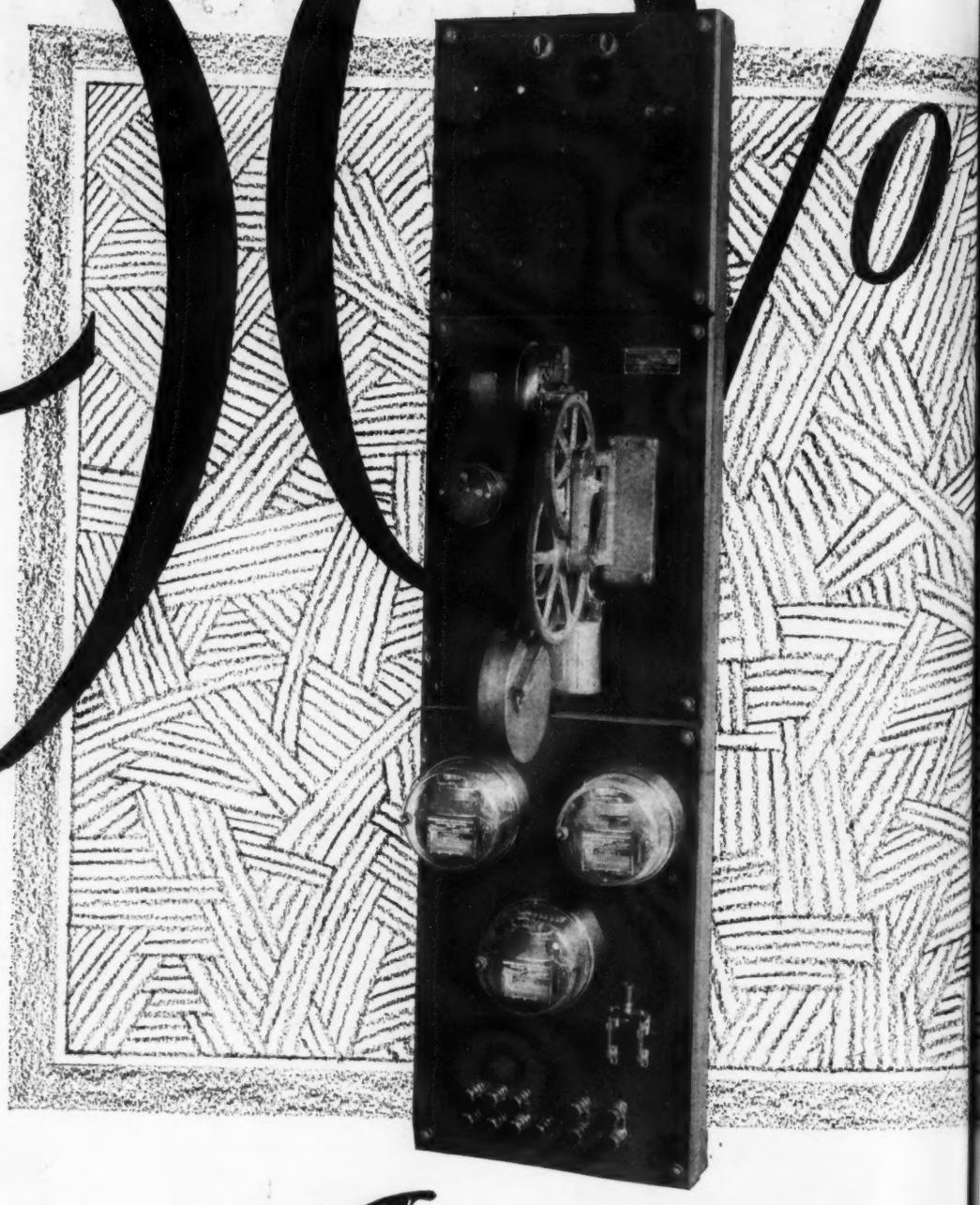
Bogalusa, La.



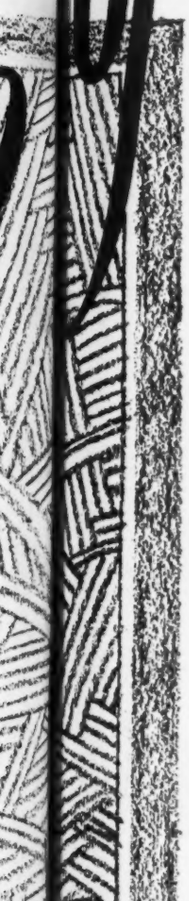


EW 9-25-Gra

90%



AUTOMATIC
Manufacturer of Automatic
517 EAST
DETROIT,



# of Line Troubles Are Temporary—

avoid serious outages with

Type M.I. Reclosing Equipment

90% of line troubles have a duration of seconds—the line may be reclosed back into service at once.

If you have Type M.I. Automatic Reclosing Circuit Breakers on the low side of each substation, such troubles will be taken care of automatically without attention by a watchman.

These breakers make an ordinary substation automatic, requiring only periodic inspection and lubrication.

Recloses within 10 seconds—a period which brings no complaints or damage suits. If trouble is permanent, breaker locks open after three reclosures. If three trips do not occur, the mechanism resets for a full cycle on next trouble.

Standard breaker of high interrupting capacity. Reclosing mechanism operated by amply powerful split phase motor which starts under no load. 20% voltage drop will not impair operation.

Price is astonishingly low because of standardized construction. Modern construction demands these breakers as an improvement of service and a reducer of expense.

Write for Bulletin No. 202, which gives complete engineering data.

SWITCH Co.,
Electric Switching Equipment
LARNED ST.,
MICHIGAN

Automatic Switch Co.,
817 E. Larned St., Detroit, Mich.
Send me Bulletin No. 202.
Name .....
Address .....

Low Cost per Year of Service

LONG-BELL

Creosoted Yellow Pine

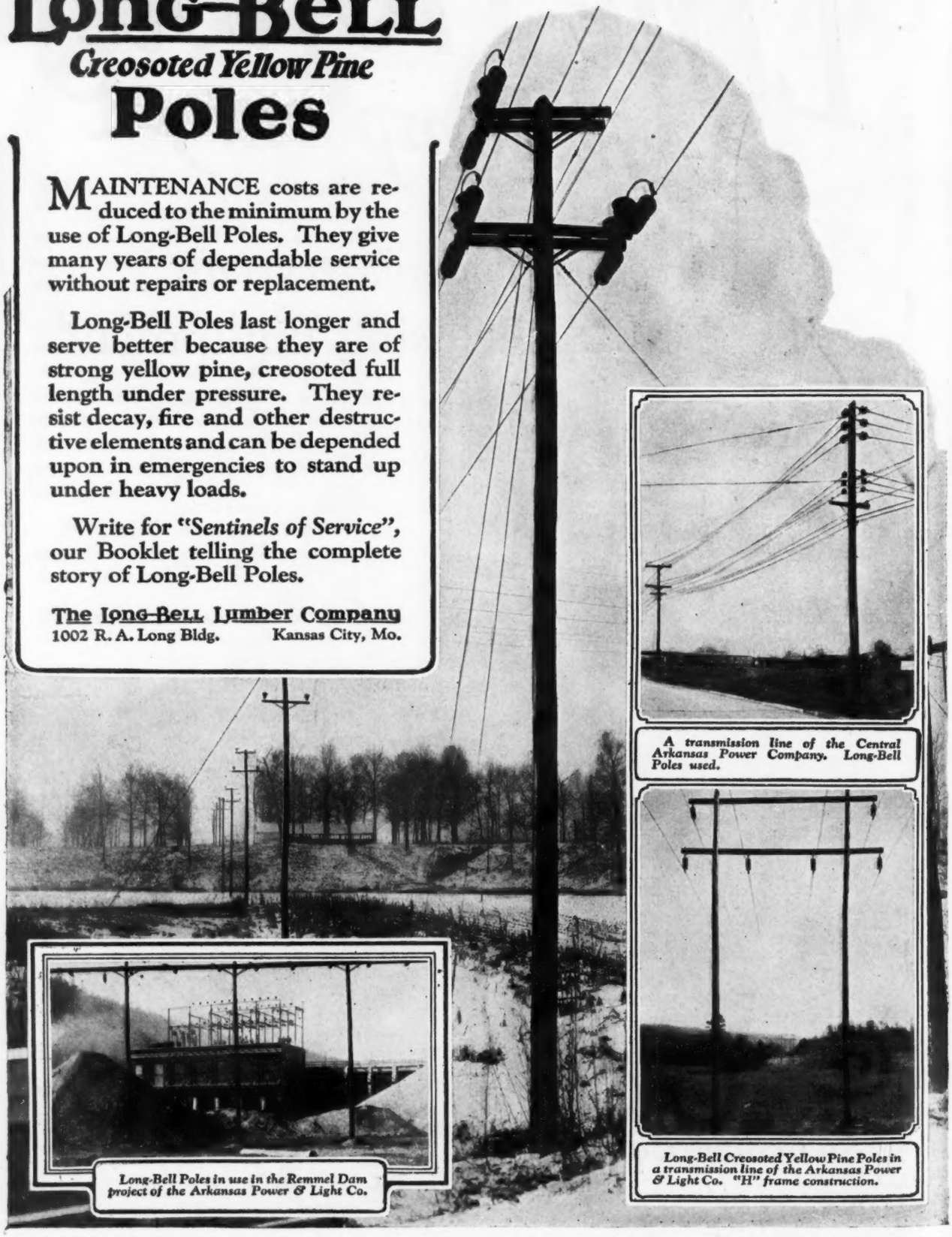
Poles

MAINTENANCE costs are reduced to the minimum by the use of Long-Bell Poles. They give many years of dependable service without repairs or replacement.

Long-Bell Poles last longer and serve better because they are of strong yellow pine, creosoted full length under pressure. They resist decay, fire and other destructive elements and can be depended upon in emergencies to stand up under heavy loads.

Write for "*Sentinels of Service*", our Booklet telling the complete story of Long-Bell Poles.

The Long-Bell Lumber Company
1002 R. A. Long Bldg. Kansas City, Mo.



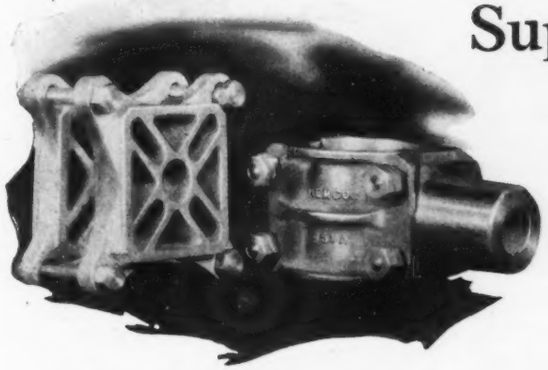
A transmission line of the Central Arkansas Power Company. Long-Bell Poles used.

Long-Bell Creosoted Yellow Pine Poles in a transmission line of the Arkansas Power & Light Co. "H" frame construction.

Long-Bell Poles in use in the Remmel Dam project of the Arkansas Power & Light Co.

ADAPTABLE

Superior Clamp Features



—for Flat Buses

The Memco Flat Bus Clamps incorporate the special Memco reversible feature. The two sides are offset and reversible, thus giving the clamp any capacity from one to six bars without having the bolts project far enough to be in the way. Liberally designed castings of government bronze are assembled with hot dipped galvanized steel bolts. Made in three and four bolt styles.

—for Round Buses

Here are several decidedly important improvements. The main casting is proportioned to carry *all* the current, the clamping pieces not being depended upon for that purpose. Another feature—ribbed reinforcements obviate bending of clamp at the bolts.

Heavy Bronze *Thru-Bolts* with jam nuts insure tight connection and eliminate stripped threads prevalent in castings assembled with machine screws. *Locked* bolt heads require use of only one wrench. Liberally proportioned castings afford low current density.

and the *Adaptable* Fittings

Comparatively few parts, but designed to permit the assembly of more than two hundred different mounting combinations.

Simplicity is accompanied by an unusual degree of interchangeability.

Memco Bus Clamps and Adapters fit every Memco standard insulator unit.

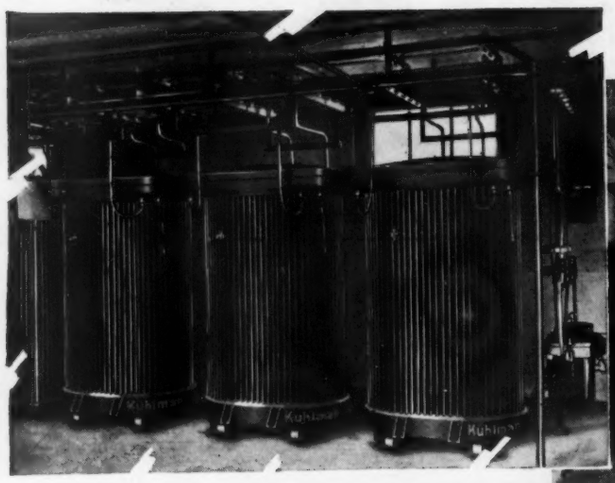
Catalog and Bulletins on request.

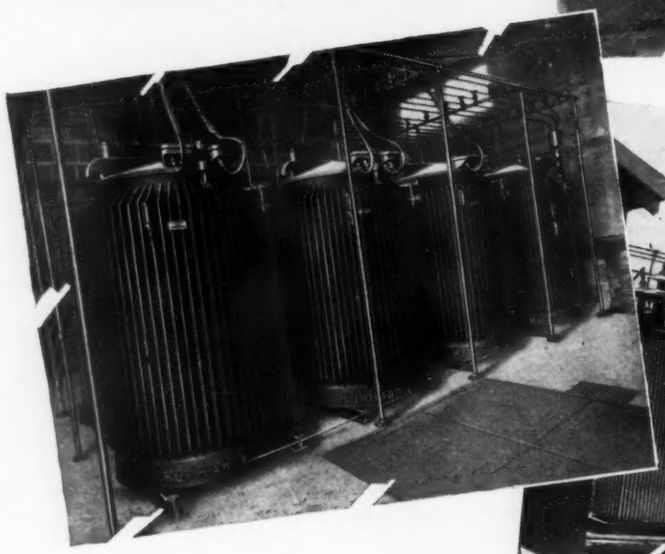
MEMCO ENGINEERING & MFG. CO., INC.

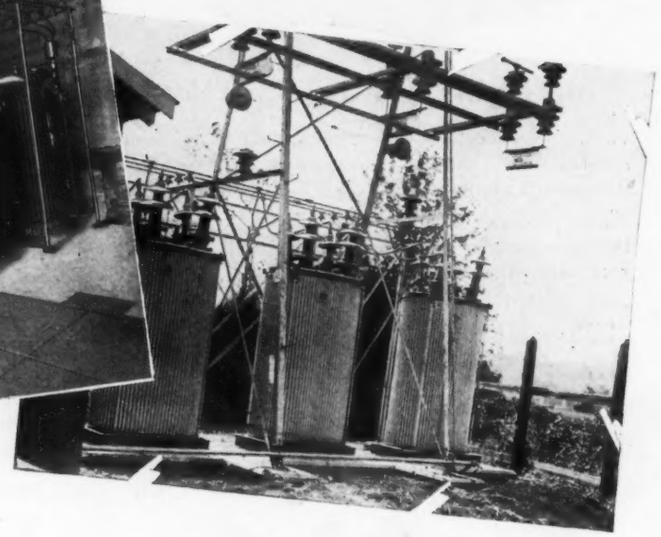
381 Hamilton St., Long Island City, N. Y.

HIGH TENSION TRANSMISSION LINE AND OUTDOOR SUBSTATION EQUIPMENT

"Best Practice" Kuhlman







THESE are typical of the many Kuhlman Transformer Installations that are working efficiently and with unfailing reliability in Central Stations, Substations, Industrial Plants, Public Buildings, Railroads, Theaters, Street Lighting Service and various other specialized fields that require transformers.

SINCE 1893 - BUILDERS OF TRANSFORMERS FOR

approves Transformers

"Best Practice" in Central Station and Substation Construction has placed its mark of approval upon Kuhlman Transformers. This is evident from the rapidly increasing demand for Kuhlman Transformers that has recently necessitated building large additions to the Kuhlman plant.

Kuhlman Transformers are the result of "best practice" in design, the selection of materials and in workmanship. The first consideration in the design of Kuhlman Transformers has always been absolute reliability in most severe service—and then to secure the highest all-day efficiency without compromising this reliability.

A premium is paid for a special silicon core steel that minimizes the core losses. The cases are built from copper-bearing steel that has a greater strength and resistance to corrosion.

Kuhlman workmen are specialists in their particular operations. The new shop buildings provide pleasant surroundings and ample light and air—the equipment is most modern. Every precaution has been taken to assure efficient production and high quality.

This is just the beginning of the Kuhlman story. Write the office nearest you for complete information and any data you may require regarding transformers.

KUHLMAN ELECTRIC COMPANY
Bay City Michigan

Sales and Service Offices

Allentown
Irving Samuels
Hunsicker Bldg.

Atlanta
E. K. Higginbottom
411 Glenn Bldg.

Baltimore
Seaboard Service Co.
206 E. Lexington St.

Boston
Geo. H. Wahn Co.
69-71 High Street

Buffalo
John E. Hoffman
280 Carolina St.

Chicago, Ill.
John R. Smith
844 Rush St.

Cincinnati
Beedle Equipment Co.
1308 Union Trust Bldg.

Cleveland
Frank Simpson
500 East 102nd St.

Dallas
F. T. Morrissey & Co.
Unit No. 2 Santa Fe Bldg.

Denver
Globe Electric Supply Co.
1843 Wazee Street

Detroit
R. P. Johnson
3-260 General Motors Bldg.

Indianapolis
Scott Jaqua Co. Inc
202 Indiana Terminal Whse.

Los Angeles
Thomas Machinery Co.
316 American Bank Bldg.

Milwaukee
Wm. H. Fernholz
1031 Clybourn St.

Minneapolis
Grant Sales Company
1004 Marquette Ave.

New York
D. F. Potter, Jr.
300 Madison Ave.

Omaha
D. H. Braymer Equipment Co.
727 W. O. W. Building

Philadelphia
H. F. Darby, Jr.
1700 Walnut St.

Pittsburgh
Continental Sales & Engr. Co.
839 Oliver Building

Salt Lake City
Stevens Sales Company
134 West 2nd South St.

San Francisco
C. F. Henderson
Call Building

Seattle
Equipment Sales Co.
314 Seneca Street

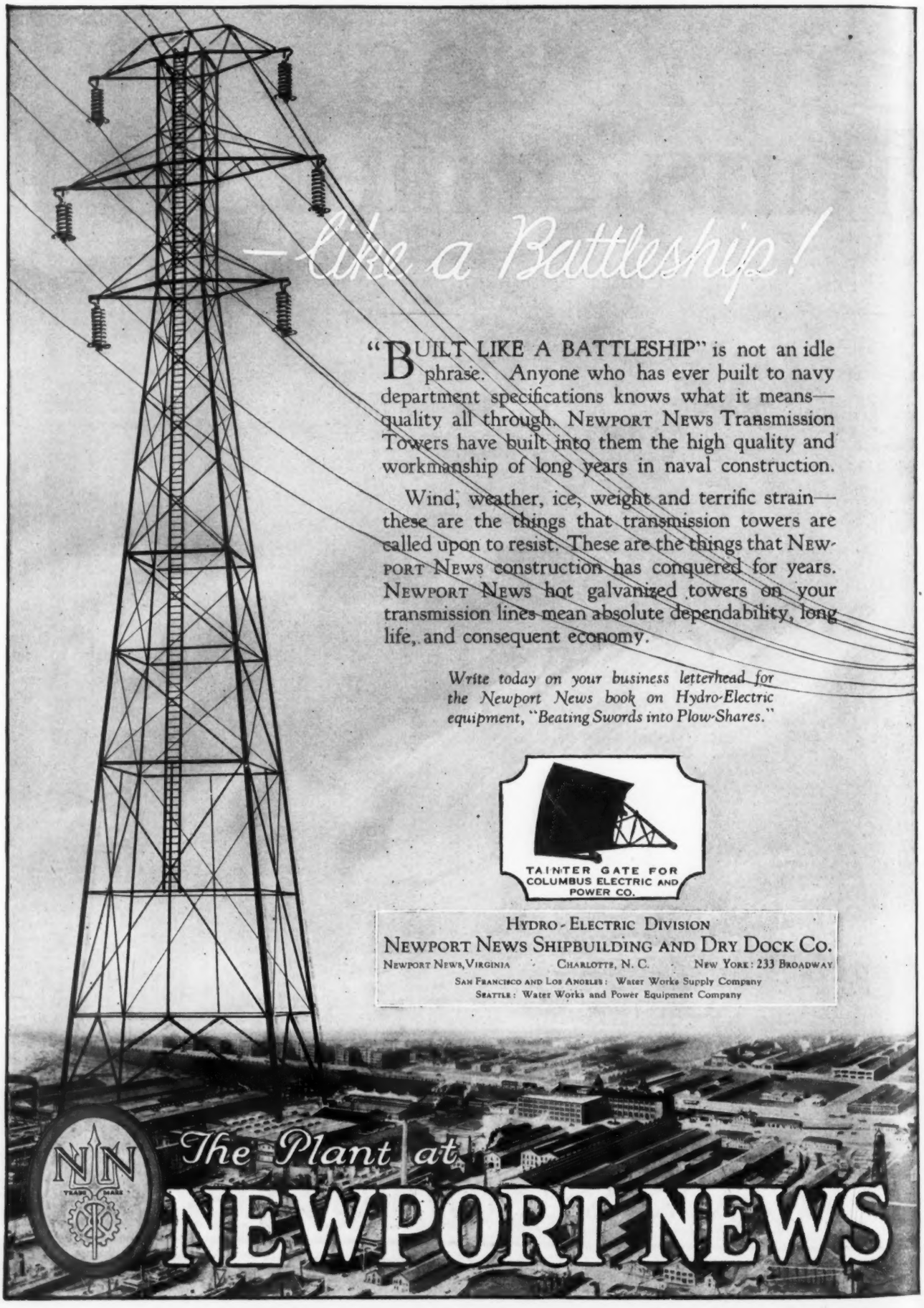
Toledo
Howard J. Wittman
424 Spitzer Bldg.

Tulsa
Dodge Electric Co.
318 S. Boulder St.

York
Harry W. Motter
335 W. Market St.

KUHLMAN TRANSFORMERS

POWER-DISTRIBUTION-STREET LIGHTING



—Like a Battleship!

"BUILT LIKE A BATTLESHIP" is not an idle phrase. Anyone who has ever built to navy department specifications knows what it means—quality all through. NEWPORT NEWS Transmission Towers have built into them the high quality and workmanship of long years in naval construction.

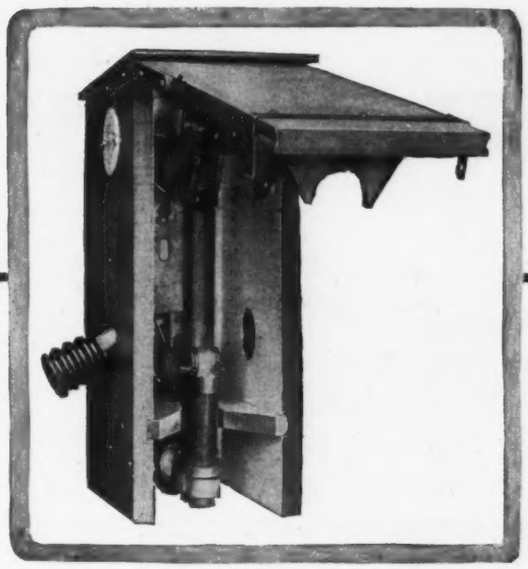
Wind, weather, ice, weight and terrific strain—these are the things that transmission towers are called upon to resist. These are the things that NEWPORT NEWS construction has conquered for years. NEWPORT NEWS hot galvanized towers on your transmission lines mean absolute dependability, long life, and consequent economy.

Write today on your business letterhead for the Newport News book on Hydro-Electric equipment, "Beating Swords into Plow-Shares."

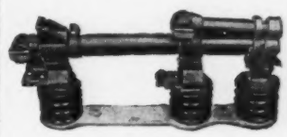
TAINTER GATE FOR COLUMBUS ELECTRIC AND POWER CO.

HYDRO-ELECTRIC DIVISION
NEWPORT NEWS SHIPBUILDING AND DRY DOCK CO.
NEWPORT NEWS, VIRGINIA · CHARLOTTE, N. C. · NEW YORK: 233 BROADWAY
SAN FRANCISCO AND LOS ANGELES: Water Works Supply Company
SEATTLE: Water Works and Power Equipment Company

The Plant at
NEWPORT NEWS



Type HQ base assembly with disconnect blade



Type HQ base assembly with fuse cartridge

Interchangeable disconnect blade

Interchangeable vacuum fuse cartridge

Wet process porcelain bushings and mountings throughout

Matthews special fuses are more exact

SAFEST

for your men and property

Matthews Fuswitches and Disconnecting Switches are so designed that the lineman or troubleman never has to touch them with his hands to re-fuse or inspect them. The boxes can be easily opened or closed and the fuse cartridge or blade entirely removed or replaced with the safety fuse puller furnished with them. They can be inspected without the necessity of disconnection. The door opens up away from the operator. All bushings and mountings are of the finest genuine wet process porcelain. This, with proper spacing of all live parts, assures ample safety from leakage and flashover.

Recently a large power company made wet and dry flashover tests on the different parts of a Type OK Matthews Fuswitch. The voltages at which flashover occurred, were all in excess of 30,000 volts, or four times the 7500 volt rating. Ask for Bulletin 501. It completely describes Matthews Fuswitches and Disconnecting Switches.

Distributors of the following Matthews products are located in all principal cities: Matthews Fuswitches and Disconnecting Switches — Matthews Scrulix Anchors — Matthews Adjustable Reel — Matthews Slack Puller — Matthews Telefault — Matthews Teleheight — Matthews Lamp Guards — Matthews Cable Clamps.

W. N. MATTHEWS CORPORATION
3702 Forest Park Blvd., St. Louis, U. S. A.

MATTHEWS FUSWITCHES

and DISCONNECTING SWITCHES

60

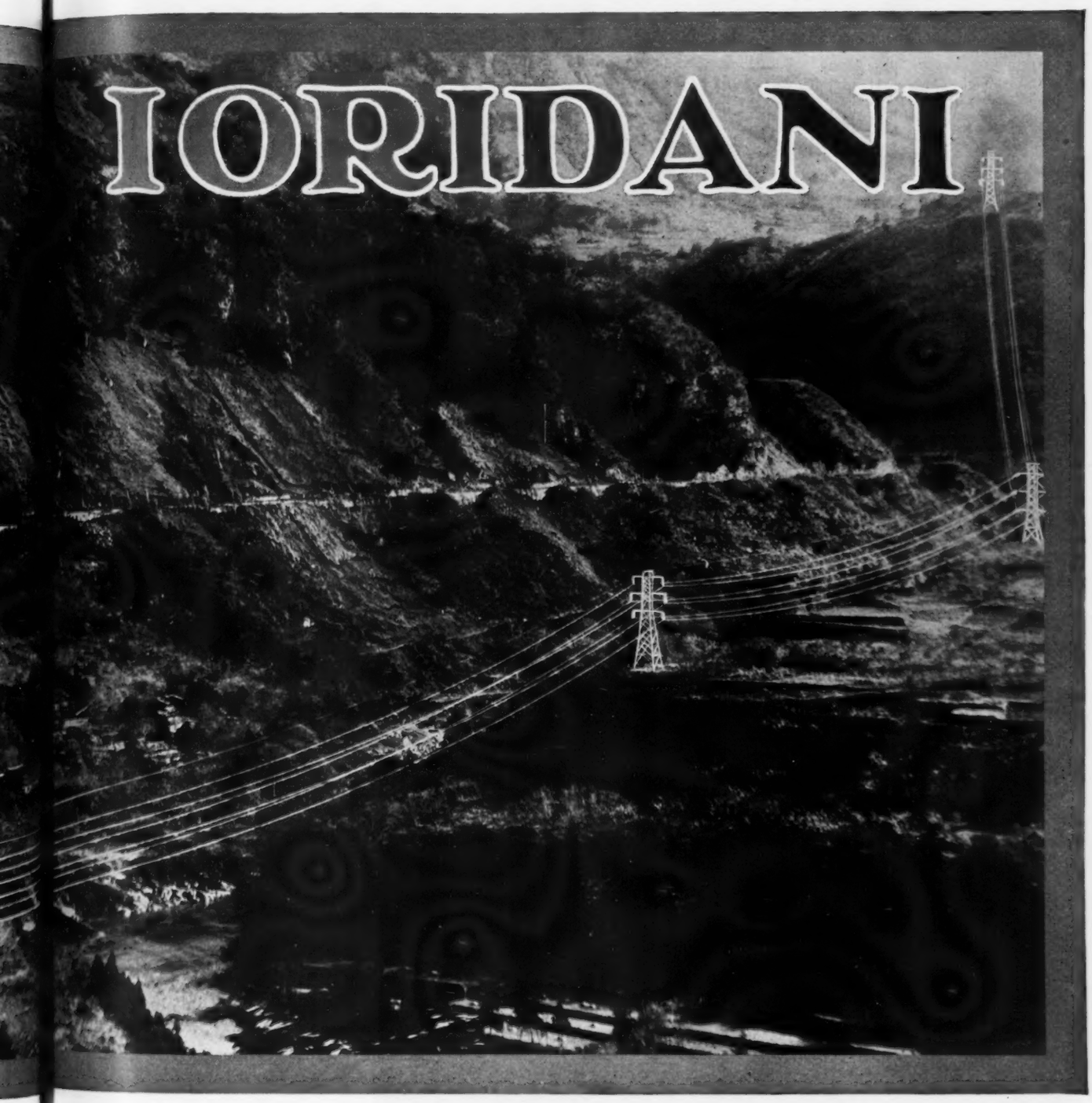
BLAW-KNOX

Nippon Electric Power Company, Osaka, Japan, Main transmission line passing through lowland near Ioridani, about four miles from Sasazu, Japan. Total length of line 194 miles. Total number of towers 1100.

BLAW-KNOX COMPANY

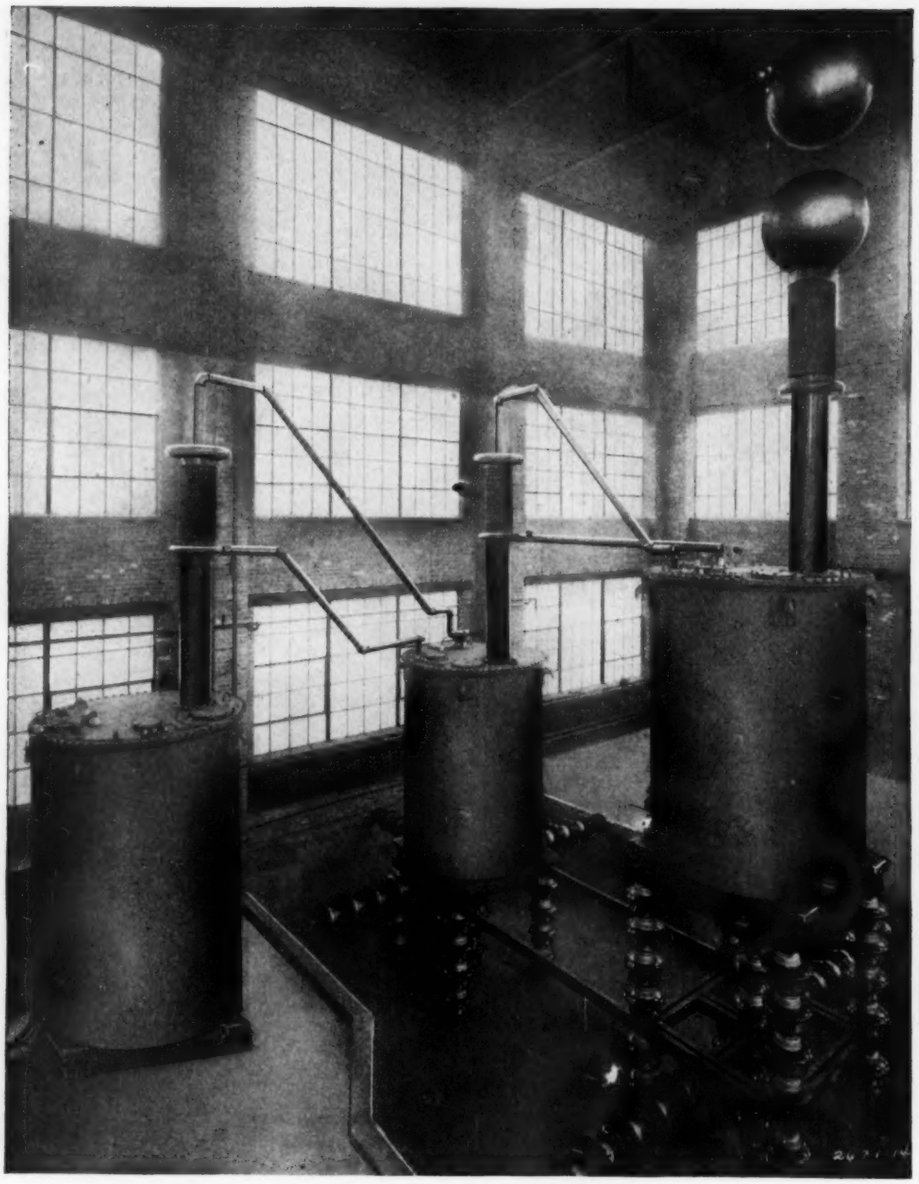
Pittsburgh, Pa.

TOWERS



BLAW-KNOX ANCHORS

Delta HIGH TENSION UNIT TYPE EQUIPMENT Star



A Section of our 750 K.V. Testing Laboratory

An Ounce of Proof Is Worth a Pound of Argument

This fact is of peculiar significance to purchasers of high tension equipment because after the purchase is made it is rather difficult to insist on a proof you did not require when selecting the equipment.

For example: when purchasing equipment rated at 132 K.V., do you know whether the manufacturer has the necessary testing facilities to prove whether or not the equipment will meet your requirements? Or, do you simply take a chance you would not take when purchasing line insulators, transformers or other equipment?

When you can buy equipment at a reasonable price and know that the guarantees or claims made by the manufacturer can be proven, is it not worthwhile to consider this point?

For example: in our 750 K.V. testing laboratory we can prove our claims as to flashover, etc. With our 50,000-lb. mechanical testing machine we can prove what we claim for cantilever, torsion, tension, etc.

Are you today buying equipment simply because of salesmen's statements or are you investigating to see if the factory he represents is really equipped to prove what he claims?

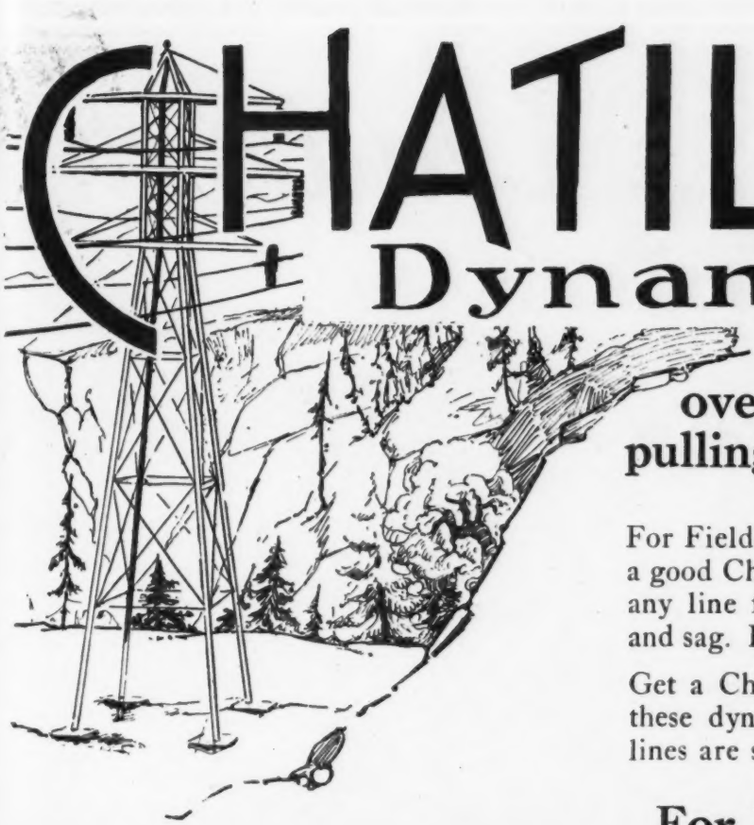
Unit Type is a proven equipment and we can prove it to any purchaser who really wants to know what he is buying.

Are You Buying Tested Equipment?

Delta INTERCHANGEABLE UNIT TYPE INSULATORS Star

DELTA-STAR ELECTRIC COMPANY, 2400 BLOCK, FULTON ST, CHICAGO, ILLINOIS.

CHATILLON Dynamometers



for stringing overhead wires and pulling underground cables

For Field Testing—there is nothing like having a good Chatillon Dynamometer on the job. Ask any line foreman who has guessed the tension and sag. He knows.

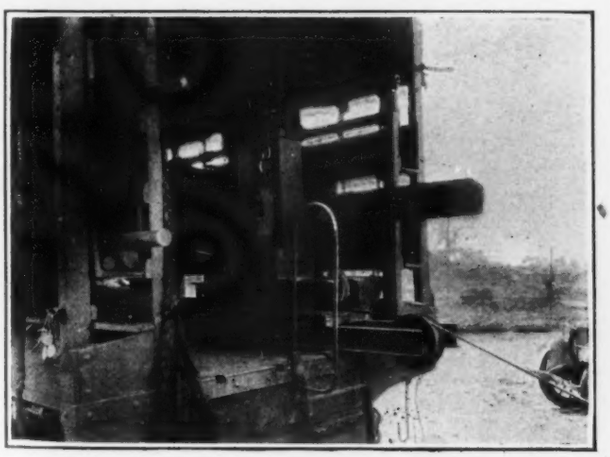
Get a Chatillon and you're safe. That is why these dynamometers go wherever transmission lines are strung.

For Pulling Underground

Large utility companies have Chatillon Dynamometers for every cable pulling gang.

Compact, durable and dependable, Chatillon Dynamometers have become the standard field testing instruments in the electrical industry.

Write for our booklet, "The Place of Field Testing in Industry." This useful booklet free to engineers.



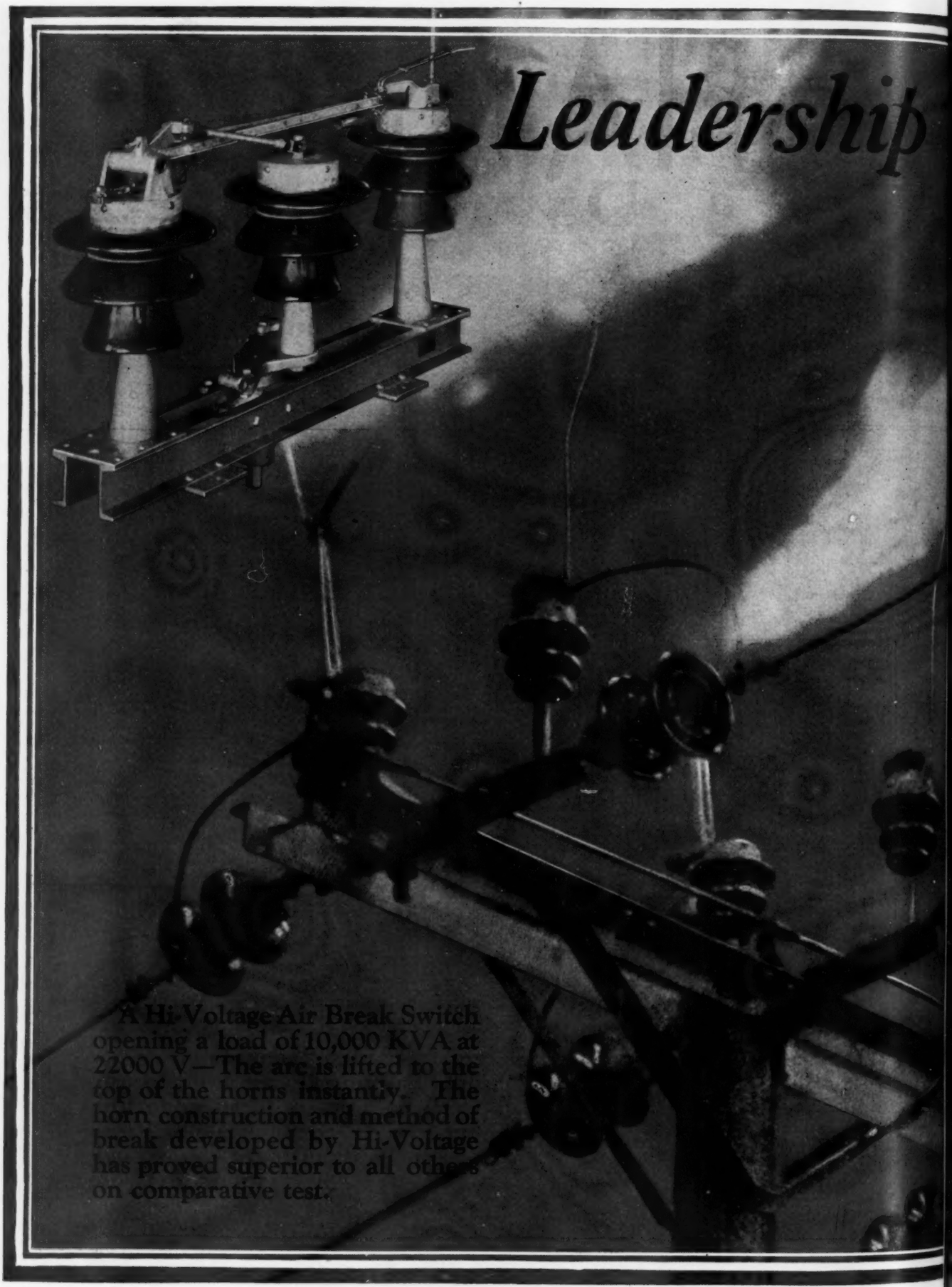
The illustration above shows how one leading Eastern company utilizes their dynamometer.

JOHN CHATILLON & SONS

Established 1835

85-99 Cliff Street, New York, U. S. A.

A side view of the same cable pulling operation.



A Hi-Voltage Air Break Switch opening a load of 10,000 KVA at 22000 V—The arc is lifted to the top of the horns instantly. The horn construction and method of break developed by Hi-Voltage has proved superior to all others on comparative test.

...n High Voltage Switches

THE HI-VOLTAGE EQUIPMENT CO. was:

First to build a really successful vertical air break switch. The vertical break has many advantages over the horizontal—

First to eliminate torsional strain from insulators. The operating insulator in a Hi-Voltage switch is subject only to side push or pull, which it is built to stand. Insulator manufacturers say that a large percentage of electrical failures are caused by mechanical failures due to wrong strains—

First to effectively protect main contacts from burning. Main contacts on a Hi-Voltage Switch are never touched by the arc. The arc strikes between the horns, and is lifted up the horns as fast as the switch arm moves—

First to perfect mechanical construction that makes easy operation certain under all conditions. Hi-Voltage will not fail to operate in conditions of sleet or ice and will work perfectly no matter how old and corroded.

99% of Hi-Voltage customers repeat because of this leadership.

Additional features are strength throughout from contact to handle—great leverage—easy action—self-aligning contact—easy installation—rating well under continuous service capacity.

80 page catalogue on application—gives complete engineering data and illustrations

THE HI-VOLTAGE EQUIPMENT CO.
3305 Croton Ave., Cleveland, Ohio

HI-VOLTAGE

Equipment Co.
3305 Croton Avenue
Cleveland, Ohio

One pipe dream that does come true

To men who have thought that electric underground construction could never be smooth and easy—here's a "pipe dream" come true in every pipe length of Bermico.

Put your wires underground in Bermico Fibre Conduit, and your worries are ended. Smooth inside and true to radius throughout, Bermico is easy to lay, and the extra long sections speed up the work.

Get in touch with a nearby Graybar distributing house. A specialist there can show you that "pipe dreams" do come true.

GraybaR

ELECTRICAL SUPPLIES

Successor to *Western Electric* Supply Dept.

Offices in 58 principal cities Executives offices: 100 East 42nd St., New York

a fitting combination

for

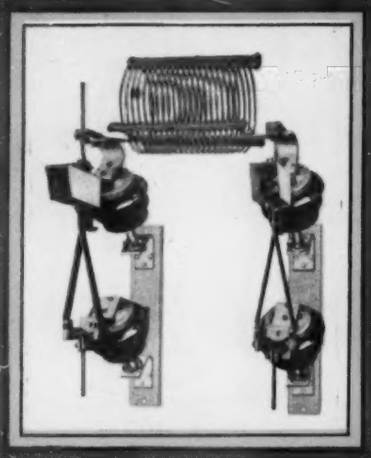
guaranteed reliability

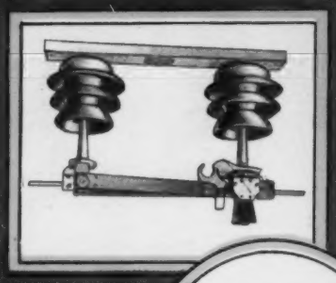
EVERY INSTALLATION PROVES IT

R&IE FRANKLIN

RAILWAY AND INDUSTRIAL ENGINEERING CO

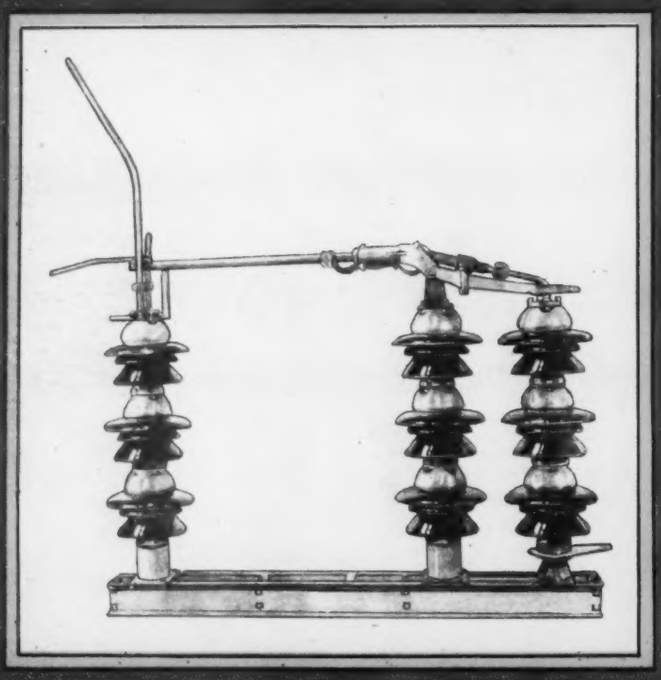
OUTDOOR EQUIPMENT

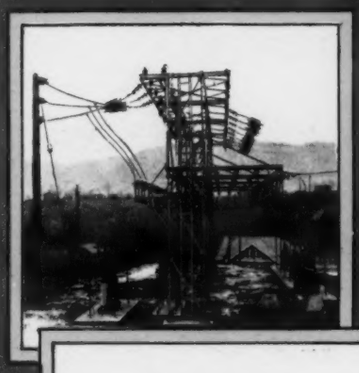


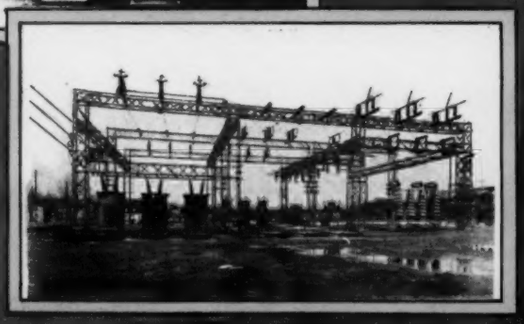


RAILWAY AND INDUSTRIAL ENGINEERING CO

THE Railway and Industrial Engineering Company and the Electrical Development and Machine Company have combined their organizations in the interest of economy and service. One company is experienced in outdoor equipment, the other indoor. The Combination has equipment to meet the most exacting requirements.







R & IE

INTERCHANGEABLE UNIT EQUIPMENT

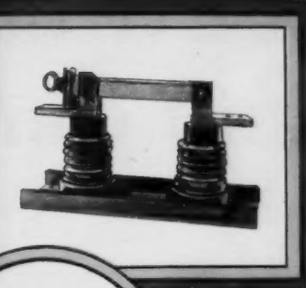
RAILWAY & INDUSTRIAL ENGINEERING CO., GREENSBURG, PA.

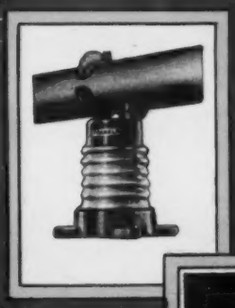
DISTRICT OFFICES

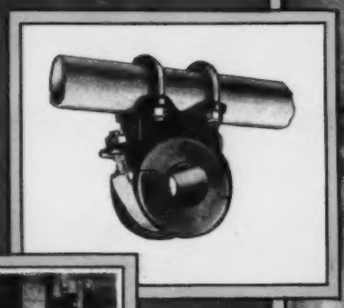
BOSTON · NEW YORK · PHILADELPHIA · CINCINNATI · CLEVELAND
PITTSBURGH · CHICAGO · ST. LOUIS · CHARLOTTE

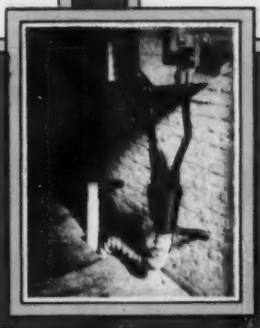
INDOOR EQUIPMENT

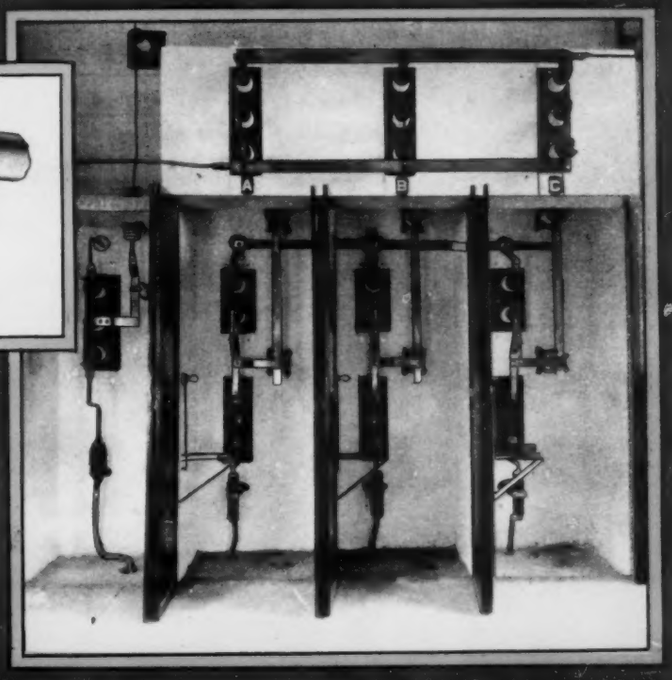
WE offer you the benefit of fifteen years EXPERIENCE in switching equipment. This accumulated KNOWLEDGE is inherent in each piece of equipment and represents real VALUE to the user. A plant of unequalled size and facilities assures DELIVERY and the QUALITY necessary for the present day needs of the PUBLIC UTILITIES.











FRANKLIN

ELECTRIC POWER EQUIPMENT

ELECTRICAL DEVELOPMENT & MACHINE CO., PHILADELPHIA, PA.

AGENCIES

Birmingham Buffalo Casper Denver Houston Indianapolis Kansas City Los Angeles Lakeland, Fla,
Rochester San Francisco Toronto and Montreal: POWERLITE DEVICES, LTD. Seattle Salt Lake City

A FEW of the many types and combinations of

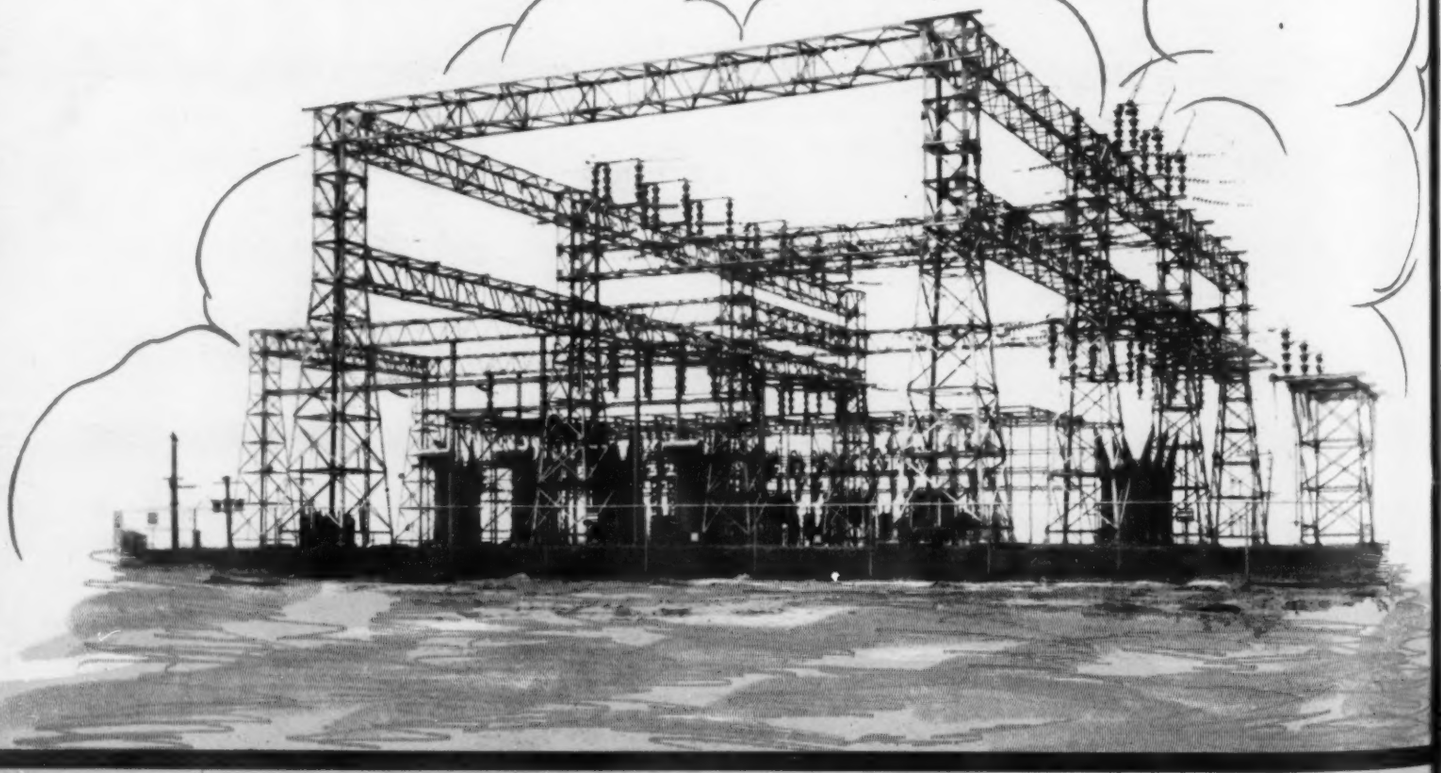
R&IE and FRANKLIN PRODUCTS

R & I E

Bus Supports.
Choke Coils.
Disconnecting Switches.
Air-Brake Switches.
Lightning Arrester Combinations.
Switch Combinations.
Fuse Mountings.
Bus Fittings.
Automatic and Motor-Operated Switches.

Franklin

Bus Supports.
Instrument Cutout Switches.
Disconnecting Switches.
Air Pressure Relays.
Potheads.
Insulators (Cleat Type).



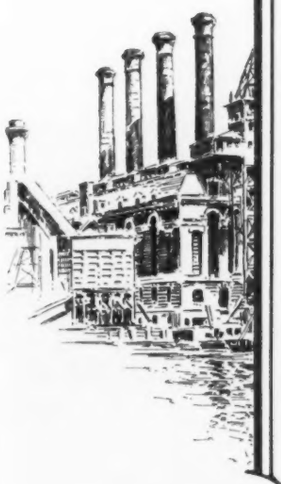
Substation *and* Generating Station Equipment

American BROWN BOVERI

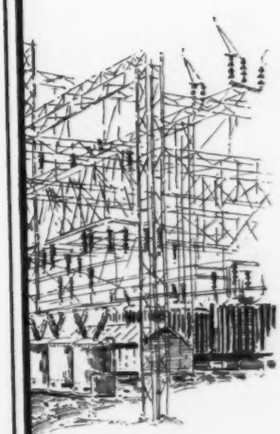
Now have orders covering the following types of equipment for

Power Station Construction

ABB



Steam Turbo-generators
Condensers
Fabricated Structural Steel
Automatic Voltage Regulators
Turbo-compressors and Blowers
Transformers
Oil Switches
Circuit Breakers



From the days news:

Electrical World,
Sept. 11, 1926

The American Brown Boveri Electric Corporation, 165 Broadway, New York, is planning extensions in its Camden (N. J.) plant, utilizing properties secured at the time of the original acquisition but not used heretofore in connection with current operations. The land primarily comprises what is known as the South Yard, located on the Gloucester side of Newton Creek. Alterations and improvements will be made in existing buildings and the necessary equipment installed. It is understood that the expansion will be used largely for the production of turbo-generating units.

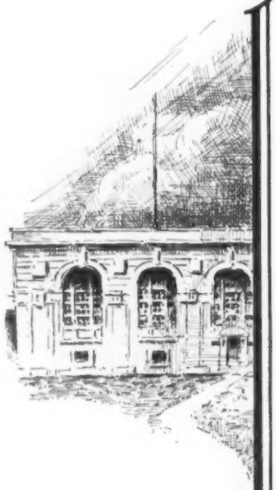
AMERICAN BROWN BOVERI

American BROWN BOVERI

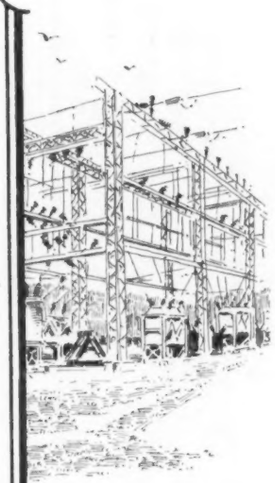
is producing under central station requisitions the following equipment for

Sub-station Construction

ABB



Mercury-Arc Power Rectifiers
Bus Supports
Disconnecting Switches
Transformers
Circuit Breakers
Potheads



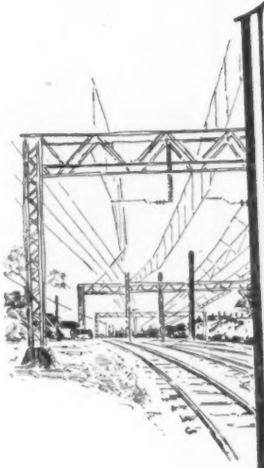
The Railway & Industrial Engineering Company, Greensburg, Pa., manufacturer of transmission, switching and protective equipment, is consolidating its plant with that of the Electrical Development & Machine Company, Philadelphia, manufacturer of the "Franklin" line of power equipment. The Railway & Industrial Engineering Company, which recently purchased property adjoining its plant, as announced in the May 22 issue of the ELECTRICAL WORLD, is enlarging its plant facilities, and a new building under construction will be occupied by the Electrical Development & Machine Company, which will move its plant from Philadelphia.

from *Electrical World*
June 26, 1926

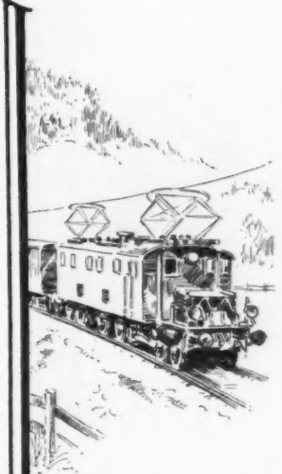
AMERICAN

Railway Electrification

ABB



Electric Locomotives
Railway Motors
Fabricated Structural Steel
Complete Substations
Mercury-Arc Power Rectifiers
Electric Locomotive Auxiliaries and Controls



from *Railway Age*
July 3, 1926

THE announcement that an order for 7 electric locomotives has been awarded to the American Brown-Boveri Electric Corporation ••••• is bound to give rise to considerable speculation. It is the announced policy of the American Brown-Boveri Electric Corporation to promote railroad electrification in particular. ••••••••••••••••••••••••• The need for electrification continues to increase slowly but steadily and it would appear that there is increasing reason for railroad associations to renew their study of this phase of the situation.

BROWN BOVERI

American BROWN BOVERI

has under production the following equipment for

Marine Construction

ABB

U. S. S. Saratoga (turbine electric propulsion)

33 U. S. Patrol Boats (Diesel propulsion)

Ferries (Diesel-electric propulsion)

Dredges—Lighters—Car Floats

AMERICAN BROWN BOVERI ELECTRIC CORPORATION

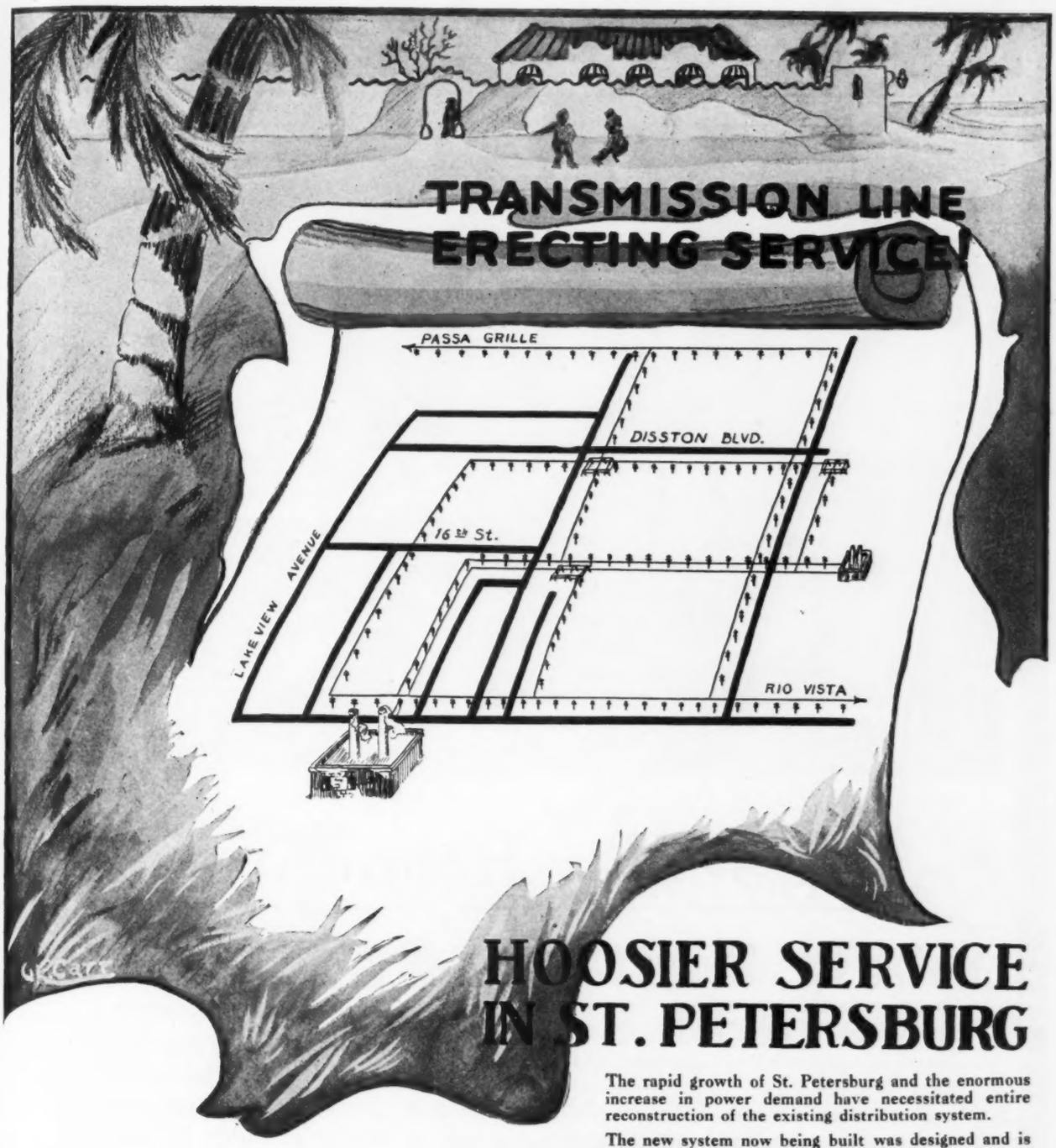
165 Broadway, New York Camden, New Jersey
842 Summer Street, Boston 92 Witherspoon Bldg., Philadelphia
230 South Clark Street, Chicago

from *Iron Age*
June 10, 1926

...repair and ... N. J., to cost close to $100,000, with equipment.

The American Brown-Boveri Electric Co., Broadway and Fairview Street, Camden, N. J., operating at the former plant of the New York Shipbuilding Co., is said to have plans under way for a shop addition, 60 x 175 ft., to cost more than $50,000 with equipment. It will advance operations at the yard, and has developed a system of standardized ship construction for larger output. Contracts have just been received for the building of 33 steel patrol boats for the United States Coast Guard Service, to cost $63,000 each, and for 6 Diesel engine-electric ferry boats for the Erie Railroad, New York.

AMERICAN BROWN BOVERI



HOOSIER SERVICE IN ST. PETERSBURG

The rapid growth of St. Petersburg and the enormous increase in power demand have necessitated entire reconstruction of the existing distribution system.

The new system now being built was designed and is being constructed under the direction of the General Engineering & Management Corporation, 165 Broadway, New York City, who is operating for the Pinellas County Power Company, St. Petersburg, Florida.

The initial system consists of a 11,000 volt belt around the city with four 4500 volt step down substations for primary distribution.

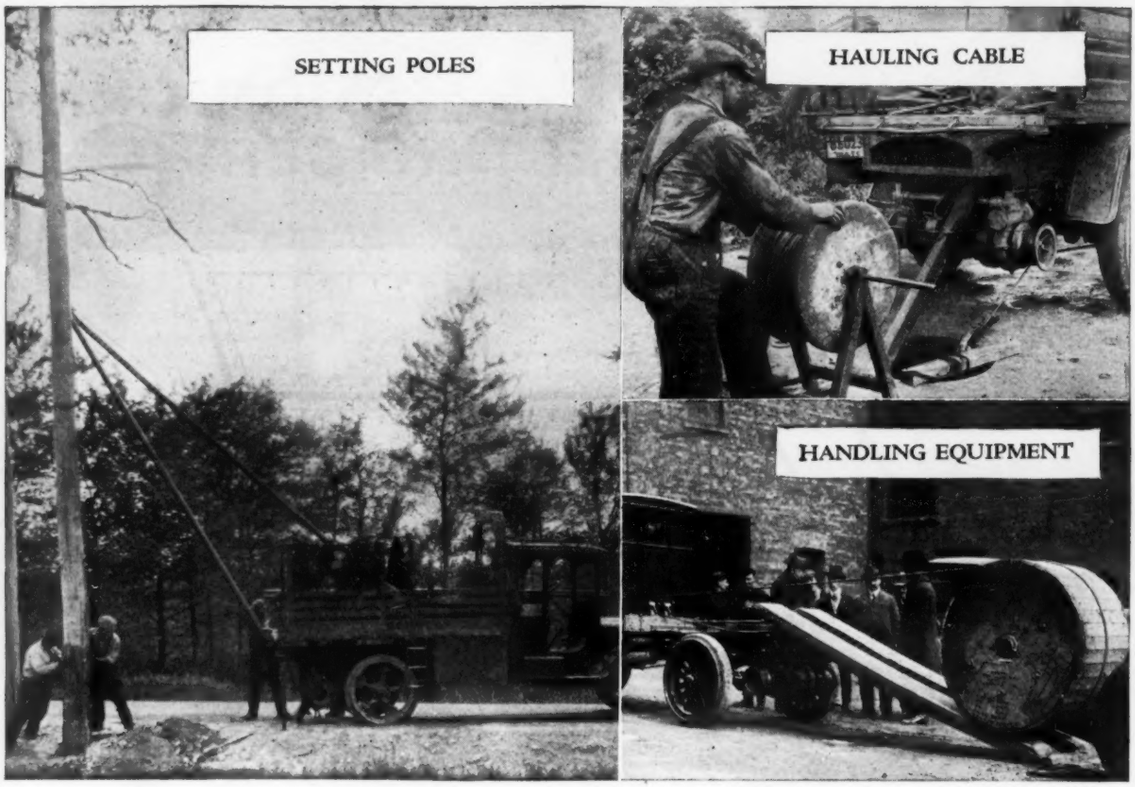
You furnish the materials—We do the rest.

Hoosier Engineering Co.

Erectors of Transmission Lines

INDIANAPOLIS

MEAD-MORRISON



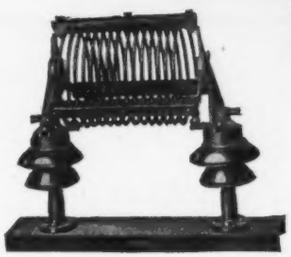
A 3-Way Economy

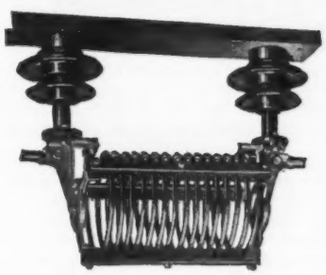
Mead-Morrison Underslung Winches save time and labor on three important operations. On pole-setting work an Underslung and Derrick can with average conditions set 100 poles a day. Only three men are required in the crew. Cable Hauling is reduced to a simple operation and is speeded up at least 50% over other methods. The Mead-Morrison Underslung pulls underground and aerial. Heavy, bulky loads are handled without the help of extra hands. The Underslung Winch on a truck makes a portable source of power available for any job of handling, hoisting or hauling.

Economies like the above explain why one leading Public Utility has more than 60 trucks equipped with Mead-Morrison Underslung Winches. ***Write for Catalog No. 28.***

MEAD-MORRISON
MANUFACTURING COMPANY
926 Prescott St., Boston, Mass.
Canadian Factory: Welland, Ontario

HOISTING - HAULING - HANDLING





Built in capacities of 100, 200, 400, 600, 800, and 1000 amperes.

All iron and steel parts are galvanized or sherardized

Braced for Strength

Each turn of the solid copper wire in this G-E Choke Coil is ***braced—braced*** at three points on the circumference—

—***braced*** by heavy strips of treated maple—

—and the braces themselves are ***braced*** by the end spiders.

This construction, and the fact that the weight of the coil proper, as well as short-circuit strains, is assumed by heavy copper-alloy brackets, account for this G-E Choke Coil's extraordinary strength.

442-8

GENERAL ELECTRIC

For medium voltage — insulate with GLASS

Hemingray insulators are correctly annealed

To secure the unequaled service which only a glass insulator can give—including freedom from ageing, dielectric strength, mechanical strength, uniformity, transparency and imperviousness to water—the process of proper annealing in the manufacture of insulators is the point of supreme importance.

The Hemingray efficiency in insulator annealing is based on seventy-three years of glass making, the last fifty of which has been devoted to the production of glass insulators. During this entire period the Hemingray organization has been improving processes and methods until the Hemingray processes for making glass insulators have reached the highest perfection.

Hemingray has the most modern annealing ovens and governing apparatus obtainable. Furthermore long experience has taught Hemingray what types of insulators can be properly annealed—and designs that cannot be properly annealed. Hemingray never accepts for manufacture a design that cannot be correctly annealed. This is one of the basic reasons for the success of Hemingray Insulators.

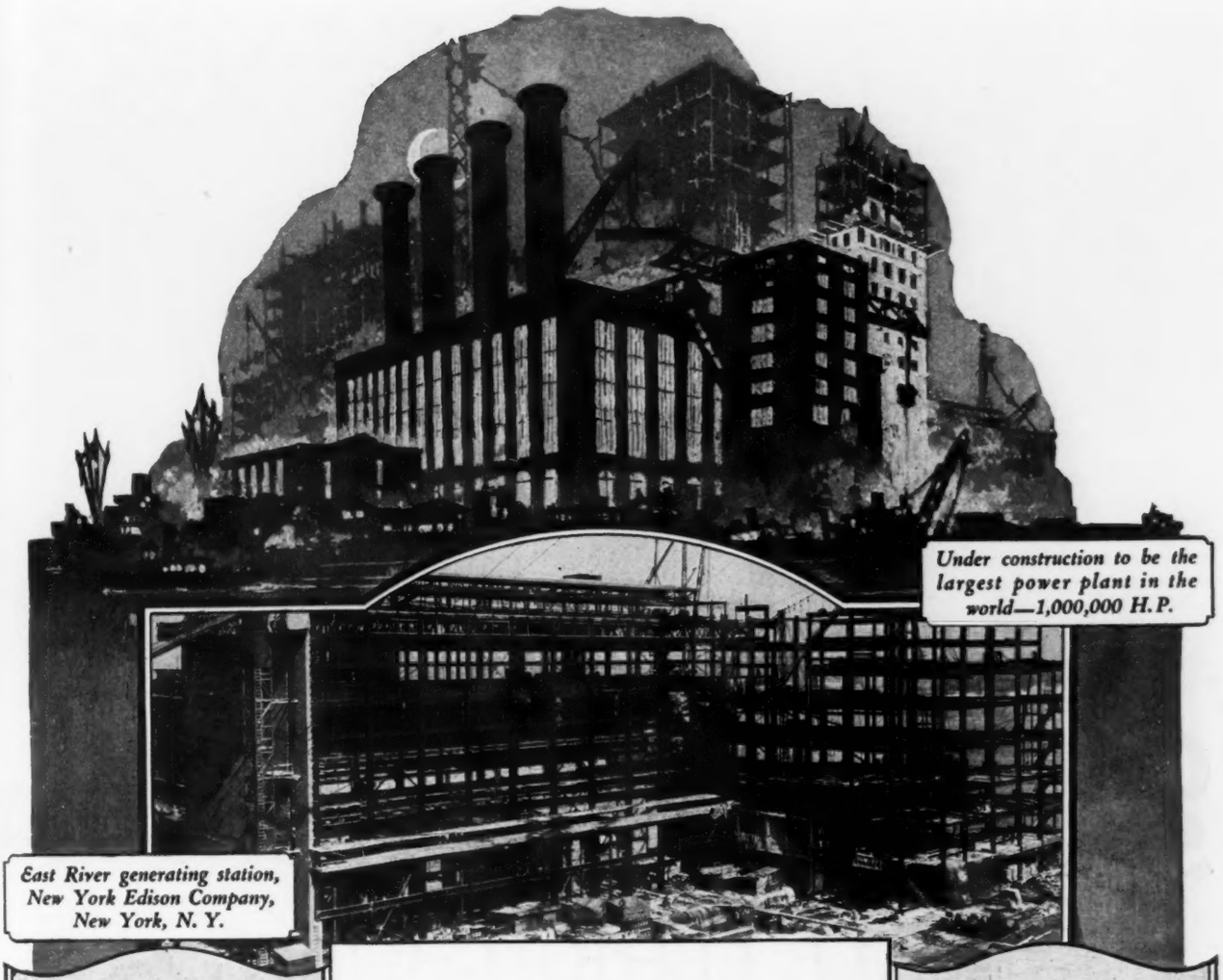
Hemingray Insulators are made in sizes for service up to 15,000 volts. The low first cost is constant low cost because Hemingray Insulators give service that is practically permanent.

The illustrations shown here indicate a few types of Hemingray medium voltage insulators. Large stocks of standard sizes are always available. Let us quote on your requirements.

Write for descriptive Bulletin

HEMINGRAY GLASS COMPANY
Offices and Factories—
Muncie, Indiana, U. S. A.

HEMINGRAY



Under construction to be the largest power plant in the world—1,000,000 H.P.

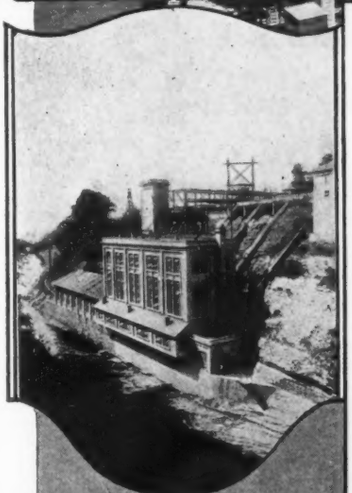
East River generating station, New York Edison Company, New York, N. Y.

IS your power plant on a par with the rest of your business?

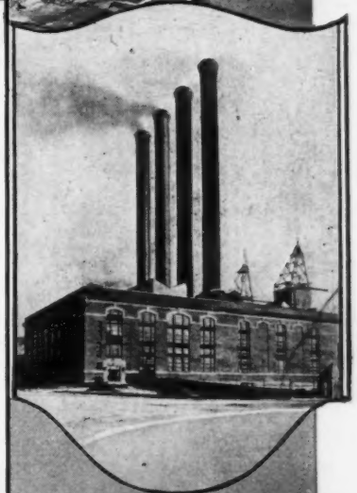
Have you the advantage of all that has been done to apply mass production principles to steam and power generation?

The same talent which has developed some of the greatest utility plants in the world, embodied in our staff of 360 engineers and architects, is at your service.

We are designing power plants in terms of tomorrow. We are ready to serve you to-day.



Trenton Falls Station, Utica Gas and Electric Co.



Millers' Ford Station, Dayton Power and Light Co.

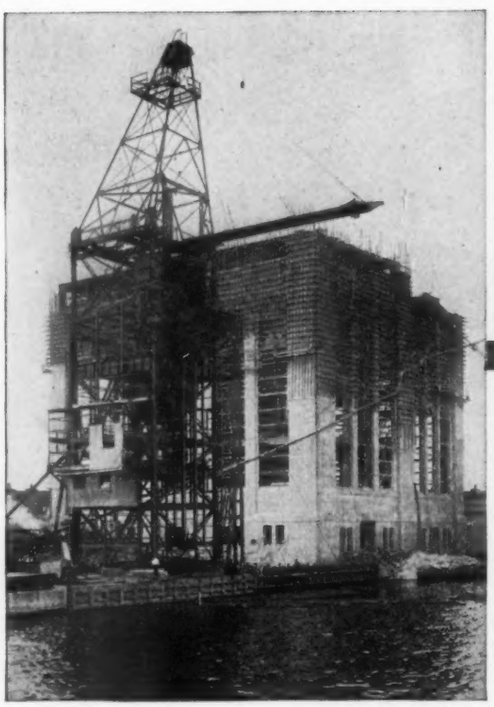
The greatest single factor in plant economy is DESIGN

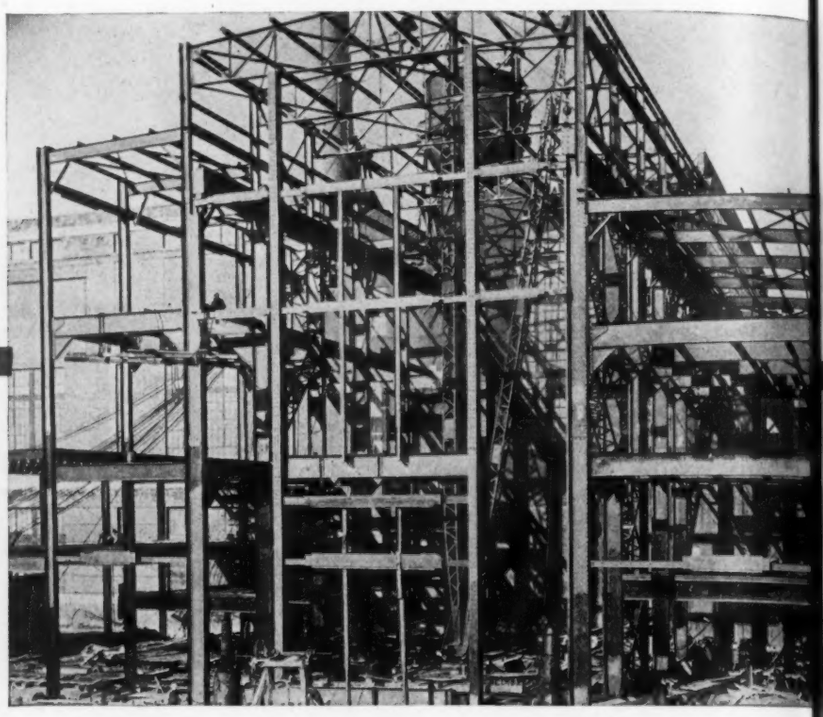
55 DUANE STREET

THOMAS E. MURRAY INC.

DESIGNING & CONSULTING ENGINEERS & ARCHITECTS

NEW YORK, N. Y.





Coaling Station *to* Power Plant

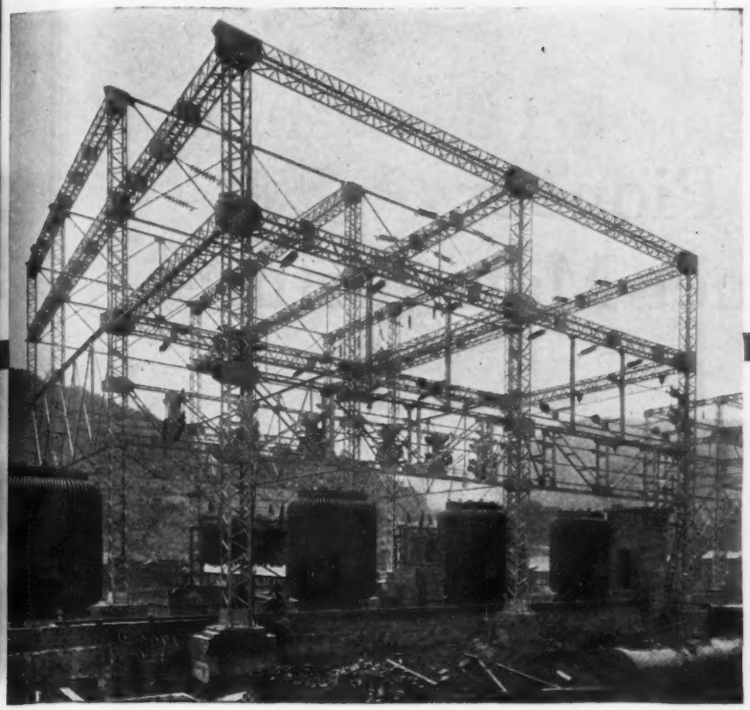
—ALL LEHIGH-BUILT

Storing up coal for the power house, actually generating power, distributing or transmitting high voltages—whatever the operation, the utmost care in design, selection of materials and construction is essential to ultimate economy. For every piece of construction, it is a big step toward greater efficiency if Lehigh Steel is used.

Lehigh offers not just good steel but expert engineering counsel, efficient design, experienced erecting service and prompt delivery.

LEHIGH STRUCTURAL

NEW YORK BOSTON PHILADELPHIA



t *to* Substation *to* Line

Many of the country's largest and most prominent power companies standardize on Lehigh Towers and Lehigh Steel for other construction jobs. Constant repeat orders are received from such well-known concerns as Stone & Webster, Inc., W.S. Barstow Management Ass'n., J.G. White Engineering Corp., Phoenix Utility, and others. Wallenpaupack, the first 220 Kv. line in the east, used Lehigh Towers.

Whatever your construction requirements, it will pay you to consult a Lehigh Engineer on your next job.

STEEL COMPANY ALLENTOWN, PA.

WASHINGTON MIAMI SAN FRANCISCO

The Pioneer in Transformer Manufacture

All-Steel Case for Transformers
Pittsburgh Polyphase Transformer
Film Radiator for Self Cooled Transformers
Ventilated Coil
Elliptical Coil Design

These are some of the features in transformer design that have been originated and developed by Pittsburgh Transformer Company engineers, and embodied in Pittsburgh Transformers.

When you have the specifications ready for your next order for transformers let us submit proposals on Pittsburgh Transformers.

Bulletin 2054
April, 1926

Pittsburgh Transformer Company

Largest Manufacturers of Transformers exclusively in the United States

Pittsburgh, Pennsylvania

Copyright, 1926

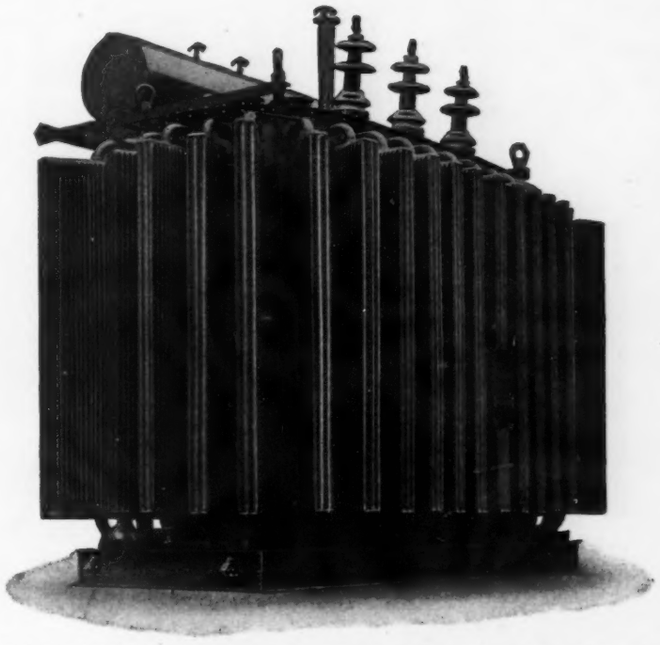
Pittsburgh Polyphase Transformer

UNTIL the Pittsburgh Polyphase Transformer was brought out, American practice strongly leaned to the use of single phase transformers, and few three phase transformers were used.

With the invention, development and sale of the Pittsburgh Polyphase Transformer, however, the use of three phase power transformers has increased enormously.

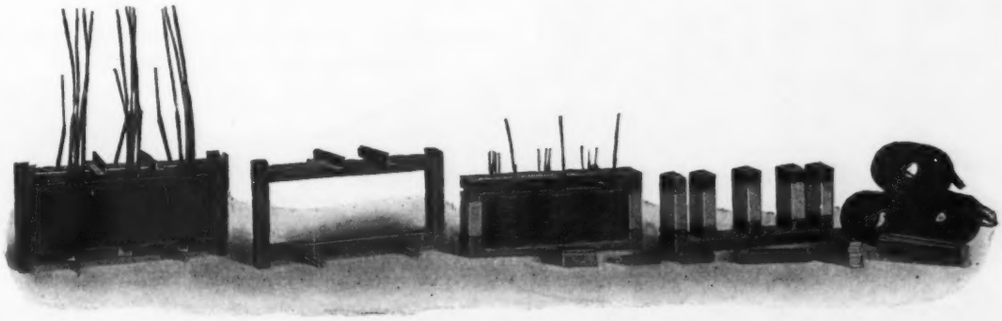
The increased production and installation of three phase transformers was stimulated and brought about by the introduction of the Pittsburgh Polyphase Transformer.

The Pittsburgh Polyphase Transformer was invented and developed by Pittsburgh Transformer Company engineers, and it drew attention to and emphasized the advantages of three phase transformers.



Pittsburgh Polyphase Power Transformer with Pittsburgh Film Radiators and Expansion Tank Southern Colorado Power Company

The Pittsburgh Polyphase Transformer gave to the electrical industry not simply a three phase transformer, but a transformer with the advantages of improved and more efficient operation added to the inherent advantages of three phase transformers.



Assembly of Pittsburgh Polyphase Distribution Transformer

AUTHENTIC statistics show yellow pine as highest in breaking, impact and crushing strength. This great strength is lasting. Properly creosoted pine poles, and ***International*** poles are properly creosoted, retain their original strength and are as strong after years of service as when installed.

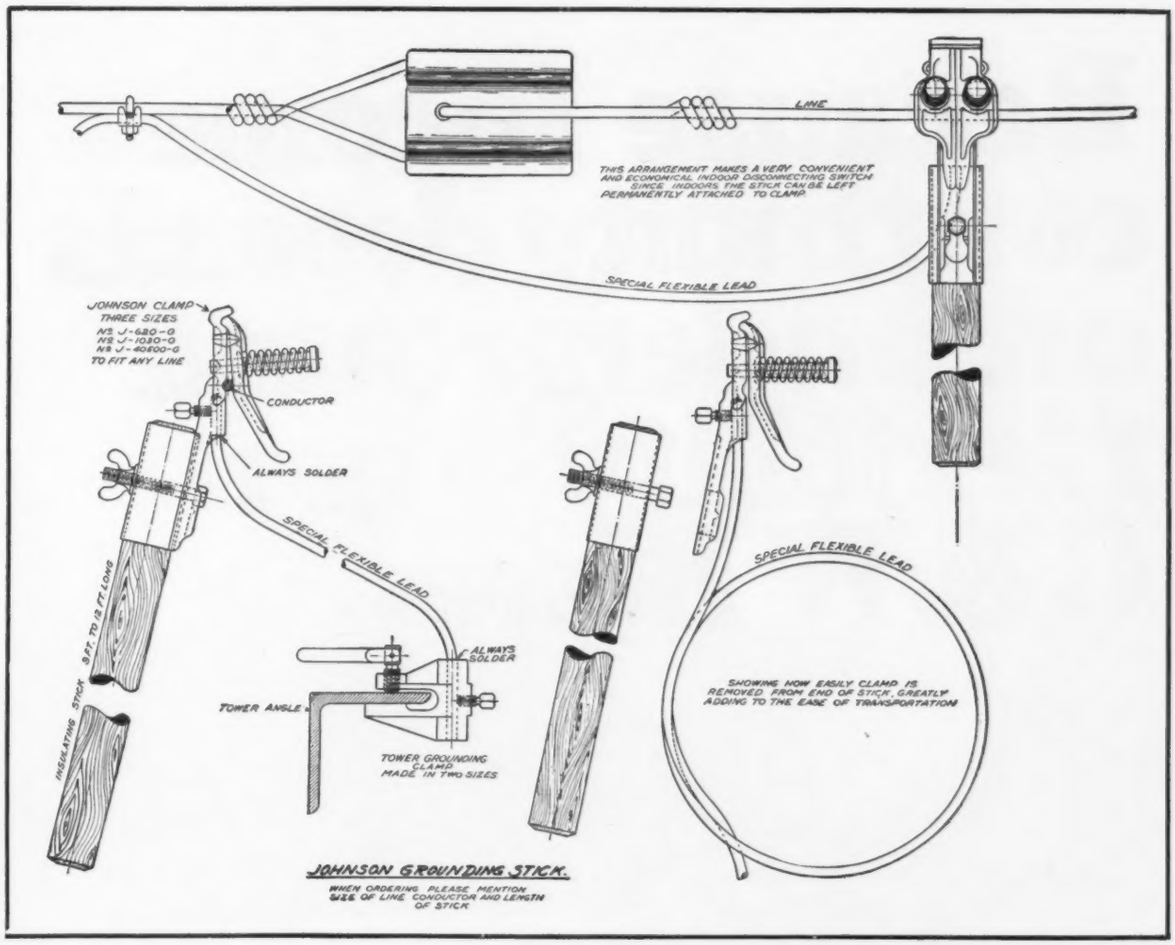
Public utility officials find that these poles combine greatest strength and greatest durability. They have learned that lines built of creosoted pine poles give the most reliable service the year round, and the lowest annual cost.

When the extreme test comes during raging storms, these poles stand up under the strains that prove so disastrous to other poles.

Illustration shows International poles between Pueblo and Canon City in service of the Southern Colorado Power Co.

International Creosoting & Construction Co.
Galveston—Texarkana—Beaumont

International
Creosoted Yellow Pine Poles


LINE
THIS ARRANGEMENT MAKES A VERY CONVENIENT AND ECONOMICAL INDOOR DISCONNECTING SWITCH SINCE INDOORS THE STICK CAN BE LEFT PERMANENTLY ATTACHED TO CLAMP
SPECIAL FLEXIBLE LEAD
JOHNSON CLAMP THREE SIZES No. J-620-G No. J-1030-G No. J-40600-G TO FIT ANY LINE
CONDUCTOR
ALWAYS SOLDER
SPECIAL FLEXIBLE LEAD
INSULATING STICK 8 FT. TO 18 FT. LONG
ALWAYS SOLDER
TOWER ANGLE
TOWER GROUNDING CLAMP MADE IN TWO SIZES
SPECIAL FLEXIBLE LEAD
SHOWING HOW EASILY CLAMP IS REMOVED FROM END OF STICK, GREATLY ADDING TO THE EASE OF TRANSPORTATION
JOHNSON GROUNDING STICK.
WHEN ORDERING PLEASE MENTION SIZE OF LINE CONDUCTOR AND LENGTH OF STICK

The Johnson Ground Stick

for perfect safety!

Above are shown details of this practical economical device which consists of a ground attachment and a regular Johnson Clamp—specially built and mounted on the end of a stick. For grounding lines—this stick has no equal. For any kind of a connection to a live power line—there is no simpler, cheaper or better device than the Johnson Clamp.

This Clamp has a carrying capacity of 150 amperes although larger clamps for heavier loads are available.

To protect men working on lines, you will find the Johnson Ground Stick much safer than the old-time grounding chains and much quicker to apply. For full details just mail us the coupon.

T. F. JOHNSON Jr., P. O. BOX 359, Atlanta, Georgia

Please send a complete copy of the Johnson Catalog or just the booklets checked.

- ☐ Fault Finder
- ☐ Buzz Stick
- ☐ Heavy Duty Transmission Clamp
- ☐ Electrical Hook
- ☐ Live Line Maintenance
- ☐ Skeet Switch

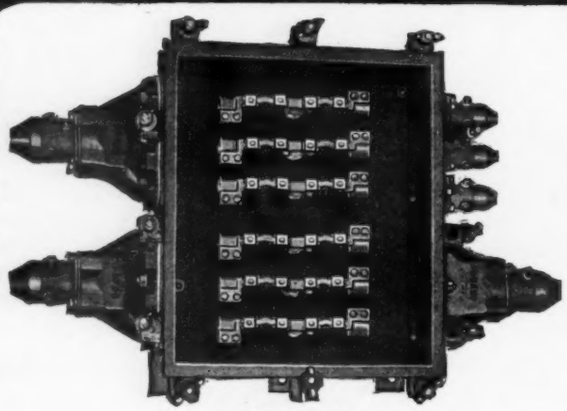
Name .....

Company .....

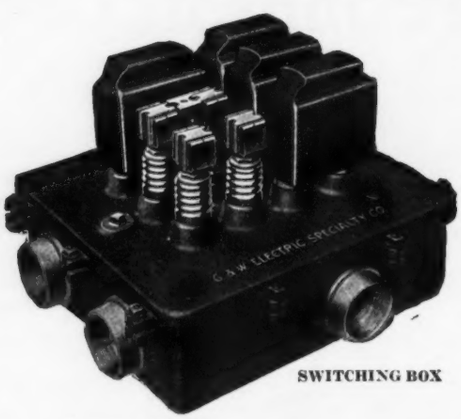
Position .....

City ..... *State* .....

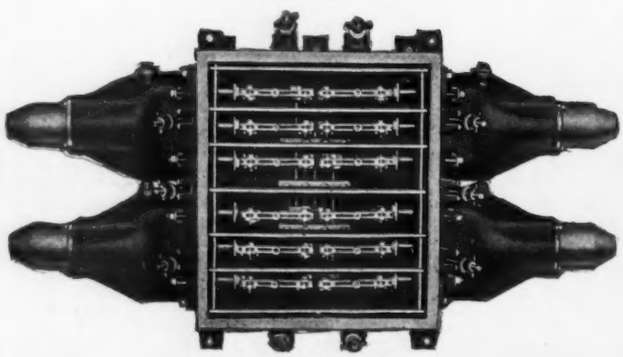
Because income continuity depends on underground flexibility—use G & W Boxes



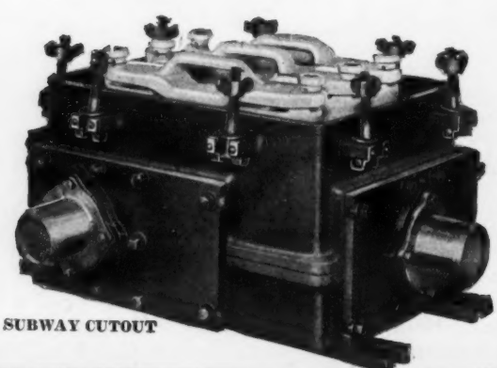
TYPE "F" BOX



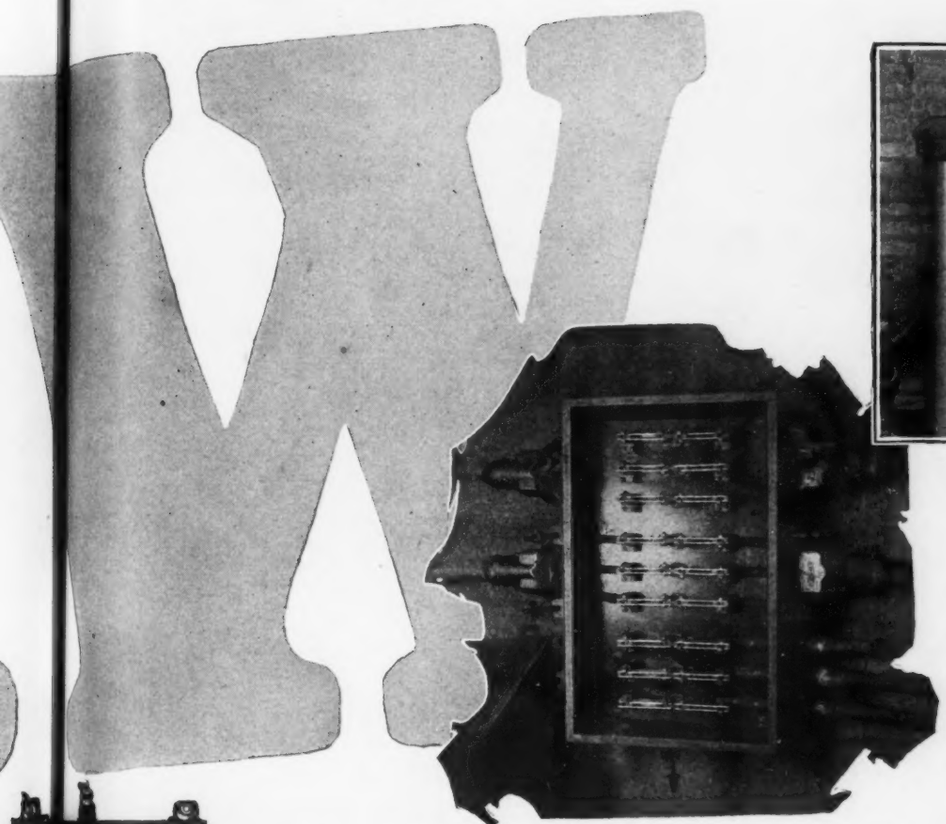
SWITCHING BOX



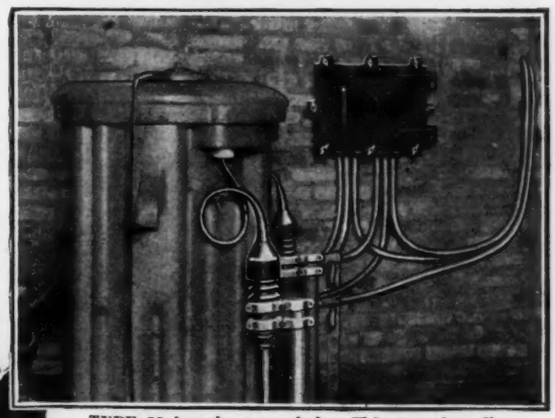
TYPE "C" BOX



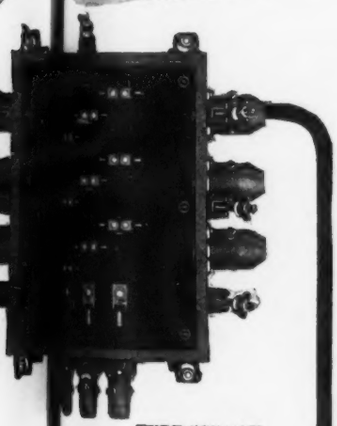
SUBWAY CUTOUT



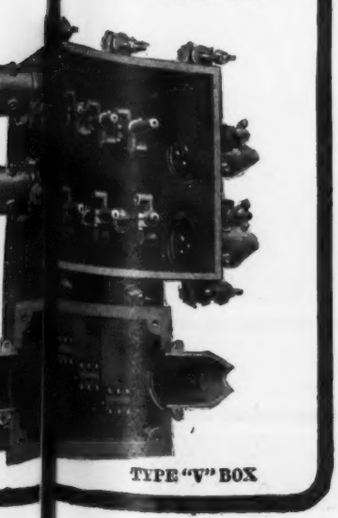
TYPE I fuse box in transformer manhole. This type is made for two and three wire—for 230 volts—for any cable—bottom of box compounded.



TYPE M box in a manhole. This type has disconnecting copper links. Otherwise has Type F fuse box construction.



TYPE "G" BOX



TYPE "V" BOX

For years G & W has been perfecting newer and better means for obtaining flexible power distribution economically. To maintain the continuity of the maximum part of the underground system during cable trouble, and do it economically, is the function of G & W underground boxes. Thus, not only is the public good will maintained, but the continuity of income as well.

The G & W unit plan of underground box construction permits the box to function even though a cable entering it is damaged. The cable is a unit right up to the bus in the box.

Fixed high standards and quality backed by carefully selected materials and expert workmanship give the G & W box maximum dependability.

Ease and speed of installation and of operation, regard for safety, and adequate voltage factors are some of the other exclusive features of G & W boxes.

Main Features of Some of the G & W Boxes

TYPE C BOX—(Photograph—3 conductor—4500 volt box. 3 way and one way blank). For voltages up to 15,000—one to four conductor—busses enclosed in bakelite tubes—only one phase exposed in one insulated cell—removable link and switch stick—cables sealed in cable head—cable heads interchangeable.

SWITCHING BOX—(Photograph—3 conductor—6600 volt, 3 way 12 tube switching box). Bottom chamber compounded. Porcelain enclosed disconnects used in manholes for quick switching of cables.

SUBWAY CUTOUT—(Photograph—3 conductor—2500 volts—3 way cutout). Enclosed fuses in porcelain chamber on 2300 volt services. Copper disconnecting link in porcelain chamber for voltages up to 4500 volts. Bottom chamber compounded.

TYPE F BOX—(Photograph—3 conductor—230 volts—4 way fuse box) cable sealed in cable head—cable heads interchangeable—for voltages up to 600 volts—for any cable—busses beneath insulated base for safety.

TYPE G BOX—(Photograph—3 conductor—230 volt box—main and six branches). For voltages up to 600 volts—cable sealed in cable head—cable heads interchangeable—plain bolted connection—bus beneath insulated base for safety.

TYPE V BOX—(Photograph—3 conductor—230 volt box—main and four branches). For voltages up to 600 volts—main need not be cut and is compounded in lower chamber—branches sealed in cable head—plain bolted connection—busses beneath insulated panel.

G&W ELECTRIC SPECIALTIES

Exactly What You Want!

G & W design and manufacture practically every device for the end of a cable.

Potheads	Underground Boxes
Series Cutouts	Conduit Bells
Primary Cutouts	Ground Pipe Caps
Oil Fuse Cutouts	Ground Pipe Points
Oil Disconnects	Vault Units

G & W

G & W ELECTRIC SPECIALTY CO.
7780 DANTE AVE. CHICAGO, ILL.

"Service
is the thing"

Carney

WESTERN RED CEDAR POLES

Aeroplane view of our Minneapolis Yard and Treating Plant

"Look up please,—smile!" signalled the photographer. Click went the Camera but we didn't hear the click, neither did our smiles show. A few of the workmen can be seen if you look closely.

It is difficult to grasp the extensiveness of this far-flung concentrating yard though the following figures and your own comparisons may help you. The long poles at right of switch are 90 feet long. The largest pile in middle of yard, at the left of power plant, contains 1563 poles, 40 ft. long. Eight loaded cars are standing on track ready for out shipment. The Pentrex machine-house and roll-ways are located just beyond the loaded cars. The inset shows treating tanks which are obscure in the aero photo. Two of Minnesota's "ten thousand lakes" are seen north of this yard.

PENTREX
guarantees 3/8 to 1/2 inch penetration on every pole

MAIN OFFICES

Brande Bldg. Grinnell | Sicamous, B. C. Enderby, B. C. | Peyton Bldg. Spokane, Wash.

TREATING PLANTS

Minneapolis | Sand Point | Spokane

B.J. Carney & Co.

GENERAL SALES OFFICES

100 North 7th St., Minneapolis
214 Old South Bldg., Boston
435 Commercial Trust Bldg., Philadelphia
905 2nd Nat. Bk. Bldg., Cincinnati
115 So. Dearborn St., Chicago
839 Oliver Bldg., Pittsburgh

LAPP
INSULATORS
DO
NOT
FAIL!

Complete Service

THE service rendered by the U. G. I. Contracting Company is possible only because of the highly specialized departments in the U. G. I. organization and its many years of experience in *all branches* of industrial and public utility building.

To so build that the cost of operation can be maintained at the very minimum has for many years been a feature of our service.

THE U.G.I. CONTRACTING COMPANY

PHILADELPHIA, U.S.A.

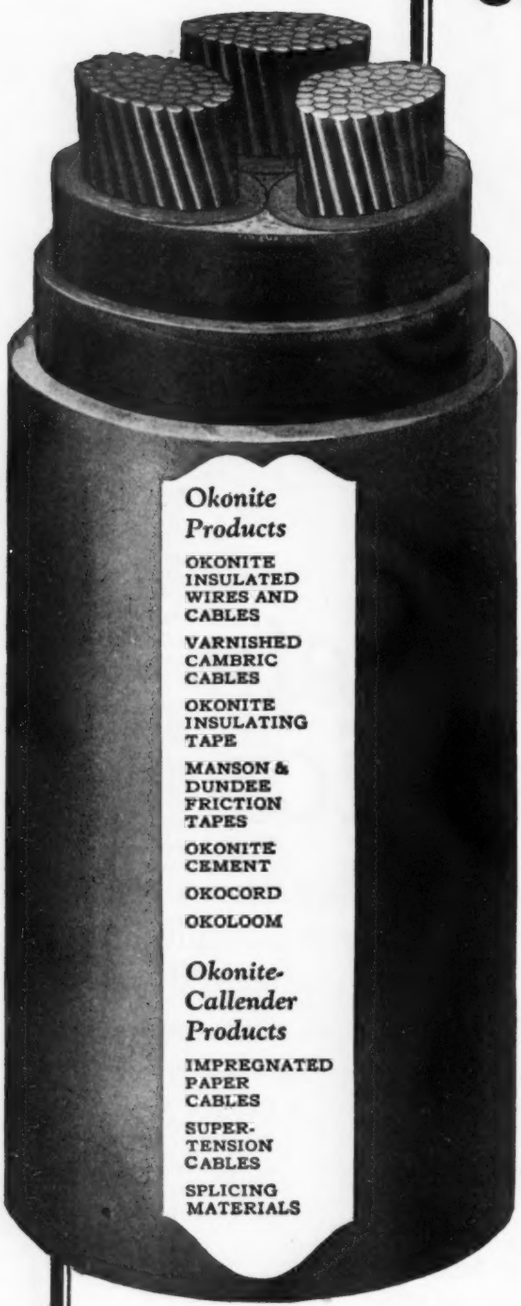
Builders of

FACTORIES POWER PLANTS BRIDGES GAS PLANTS
PUBLIC WORKS

Peoples Gas Building
Chicago

Healy Building
Atlanta

COPPER-
PAPER-
OIL-
LEAD



AN impregnated paper cable is more than merely copper, paper, oil and lead.

Anyone can wrap a copper conductor with paper, impregnate with oil, and encase the whole in lead, but there are very few who can make an impregnated paper cable.

Electrical and mechanical tests will give you an indication as to whether you are merely buying a certain quantity of copper, paper, oil and lead, or a dependable impregnated paper cable, but—the only sure and final test is actual service.

Okonite-Callender Impregnated Paper Cables

made by the Callender process,—have been proven in actual service for over thirty years, under all climatic conditions, and all operating voltages, to be dependable cables of the highest quality.

If you want copper, paper, oil, lead in cable which has been made by the most thorough and reliable processes, under the most expert supervision, and improved in all details by exhaustive chemical, mechanical and electrical research, then

Specify OKONITE-CALLENDER

Our electrical and chemical research laboratories and our engineering department are at your service to assist you in your problems.

We freely offer you our facilities and solicit your inquiries.

THE OKONITE COMPANY
THE OKONITE-CALLENDER CABLE COMPANY, INC.

FACTORIES: PASSAIC, N. J. PATERSON, N. J.

SALES OFFICES: NEW YORK . CHICAGO . PITTSBURGH . ST. LOUIS . ATLANTA
BIRMINGHAM SAN FRANCISCO LOS ANGELES SEATTLE

Pettingell-Andrews Co., Boston, Mass. F. D. Lawrence Electric Co., Cincinnati, O.
Novelty Electric Co., Philadelphia, Pa.

Canadian Representatives: Engineering Materials Limited, Montreal
Cuban Representatives: Victor G. Mendoza Co., Havana

Franklin relieves stresses that cause insulator breakage

The most serious criticism that can be held against modern multi-part insulators is the tendency of the top shell to crack after a few years' service. This failure is of a progressive nature and is caused by thermal stresses set up by temperature changes.

To relieve these conditions Franklin has come forward with a new design and a new method of assembly.

In the *new* Franklin Porcelain Insulators both the inner and outer surfaces of the shells have well rounded grooves. These are sufficiently deep to allow effective holding of the cement and to allow a coating of resilient material on all nesting surfaces. The cushioning effect of this resilient material takes care of the uneven expansion and contraction of the various shells—and therefore relieves the thermal stresses which cause such a large percentage of insulator breakage. The elimination of sand avoids the possibility of internal strains, created in the porcelain itself during the firing process.

These new Franklin Insulators have this tremendous advantage thermally without sacrifice of the usual high electrical characteristics or mechanical strength.

Any E. S. S. Co. Salesman will gladly call and give you complete details. Send for one today.

Manufactured by
FRANKLIN PORCELAIN CO., Norristown, Pa.

ELECTRIC SERVICE SUPPLIES CO.
Sales Agents

PHILADELPHIA
17th and Cambria Sts.

NEW YORK
50 Church St.

CHICAGO
Illinois Merchants' Bank Bldg.

PITTSBURGH
1123 Bessemer Building

BOSTON
88 Broad St.

SCRANTON
316 N. Washington Ave.

DETROIT
General Motors Bldg.

Lyman Tube & Supply Co., Ltd., Montreal, Toronto, Vancouver.

New!

Franklin *High Voltage* PORCELAIN Insulators

A Quarter Century o

Three 60 K.V.A., 6300 V. Transformers In Continuous Service 25 Years.

Packard

The Packard

Offices in Prin

Warren,

Packard is never seen,

...y of Service Testifies To "Honest Value"

In 1900, these three Packard Transformers were placed in service to furnish light and power for the Chicago Terminal Passenger Station of the Illinois Central Railroad.

They served day after day, month after month, year in and year out for 25 years, without a bit of trouble of any kind. They were retired last year—larger equipment was needed.

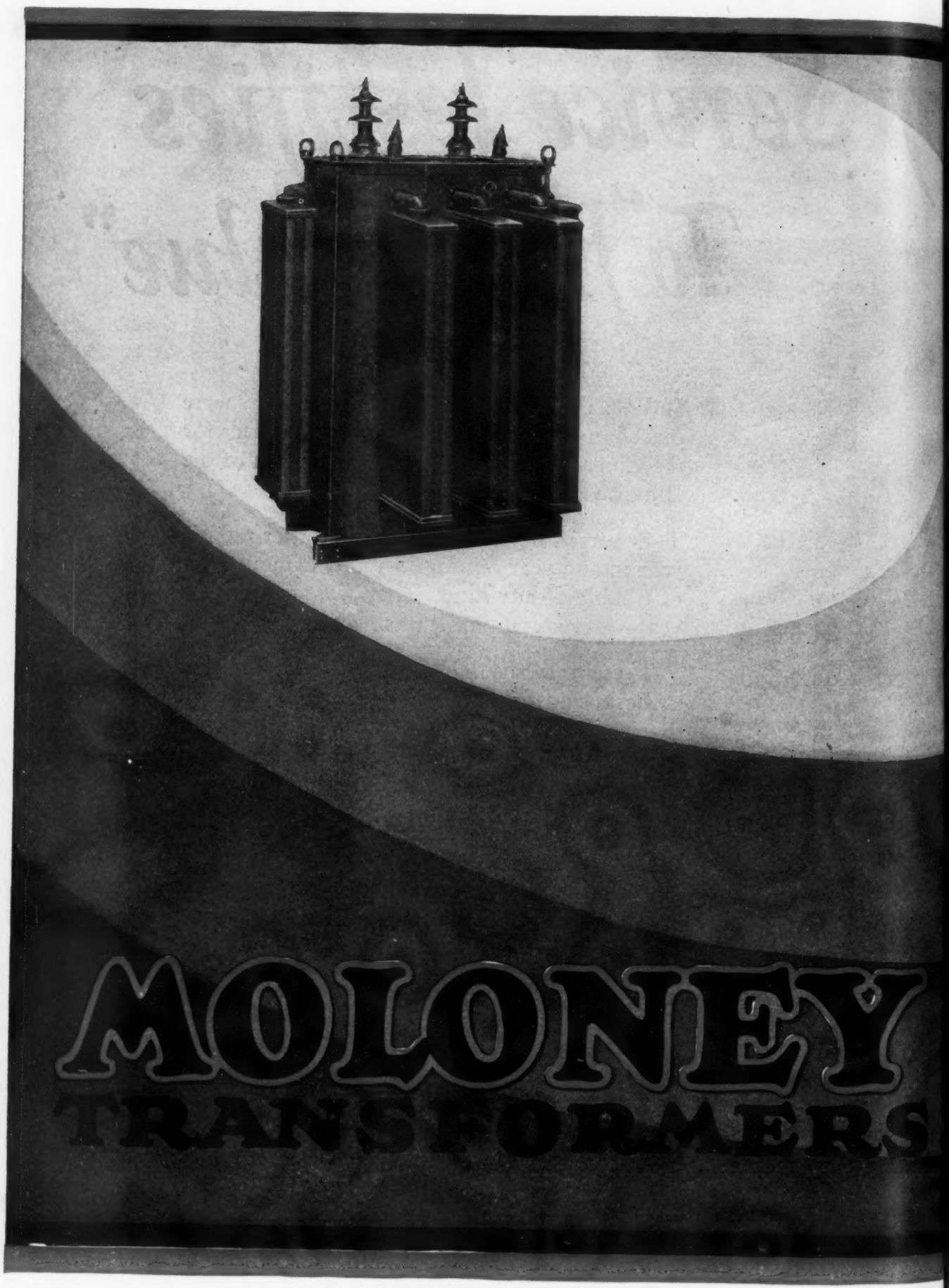
These veterans look crude in the light of modern, transformer design. But their 25 years' service testifies to the "honest value" which has been built into every Packard in the more than three decades we have been building them.

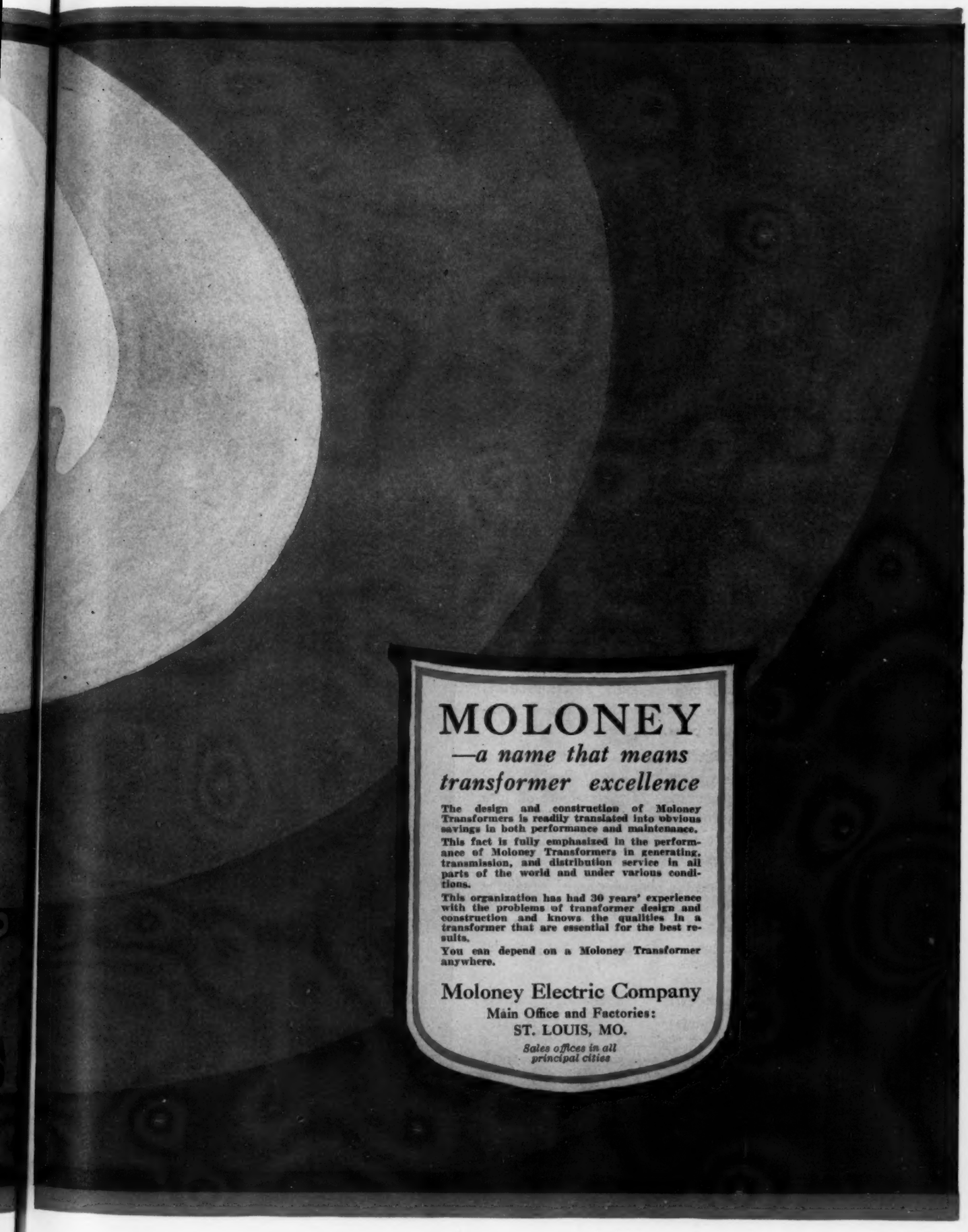
When you install Packard Transformers you obtain the most modern design and construction plus seasoned years of experience that have gone into the making of the Packard reputation for "honest value."

...l Electric Co.

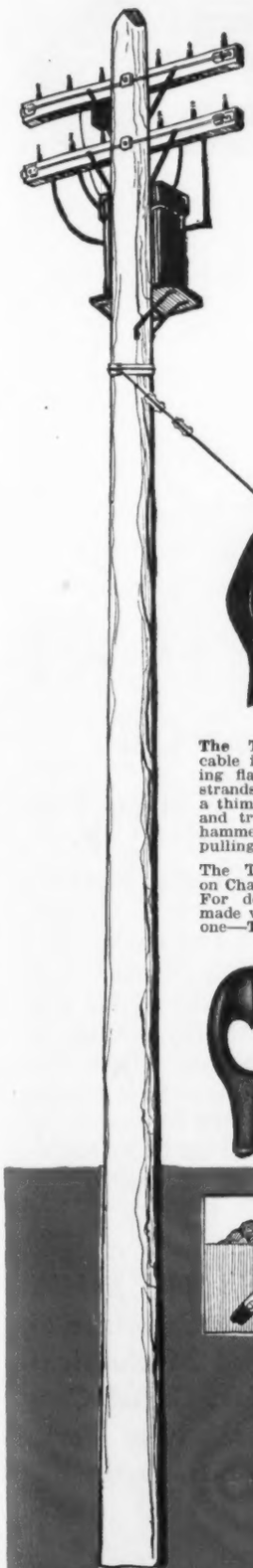
...cipal Cities
Ohio

except on goods of honest value


MOLONEY
TRANSFORMERS


MOLONEY
—a name that means
transformer excellence
The design and construction of Moloney Transformers is readily translated into obvious savings in both performance and maintenance.
This fact is fully emphasized in the performance of Moloney Transformers in generating, transmission, and distribution service in all parts of the world and under various conditions.
This organization has had 30 years' experience with the problems of transformer design and construction and knows the qualities in a transformer that are essential for the best results.
You can depend on a Moloney Transformer anywhere.
Moloney Electric Company
Main Office and Factories:
ST. LOUIS, MO.
Sales offices in all principal cities

2T6
In The Mountains
Or On The Plains
~Your Best Protection Against
Storms~Sleet~Termites~Decay
Texas "Black Beauty" Poles are of Southern Yellow Pine—a species shown by tests of the Forest Products Laboratory to be the strongest among woods commercially available for poles.
They are specially selected, and scientific creosoting, full length, by the vacuum-pressure method, secures deep and uniform penetration of the creosote oil into the pores of the sapwood—rendering the wood chemically inert and toxic to decay-producing fungi, termites, woodpeckers and other pole destroyers.
In the mountains, or on the plains—stressed by wintry winds of the North or tropical hurricanes along the Gulf Shores—Texas "Black Beauty" Creosoted Poles are "unbeatable" for long service and low cost per mile, per year.
Texas Creosoting Company
Main Office and Plant: Orange, Tex., U. S. A.
This view shows a Southern California Edison Company's project in California
Texas "Black Beauty" Poles



It's this easy!

① **Bore the hole—**
② **Drive the rod—**
③ **Hang the plate—**
④ **Fill the hole—**

Just four simple steps in the installation of a Chance Never-Creep Anchor! Far less time and labor than with the deadmen or any other patent anchor.

And when it's in, you have an anchor of permanent holding-power. Rain, snow, frost will not affect it. Conditions which render other anchors useless cannot impair the fixity of a Chance Never-Creep.

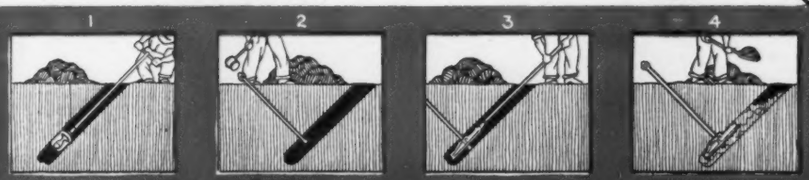
You'll find Chance Anchors in use throughout the world on light, power, phone, telegraph, and signal lines. In many construction operations they are used to guy derricks, gin poles, concrete-elevators, and similar structures. Everywhere, they give complete and lasting satisfaction—for the Chance Never-Creep Anchor holds "in spite of hell and high-water."

Order from your jobber. Write us for any special information you need.

The Thimbleye holds the cable in a true arc, preventing flattening and injury to strands. It saves the cost of a thimble—it saves the time and trouble of holding and hammering the thimble while pulling the cable.

The Thimbleye is standard on Chance Never-Creep Rods. For double guys, rods are made with two thimbleyes in one—**The Twineye.**

Chance
LINE EQUIPMENT & TOOLS
Centralia Co. Missouri



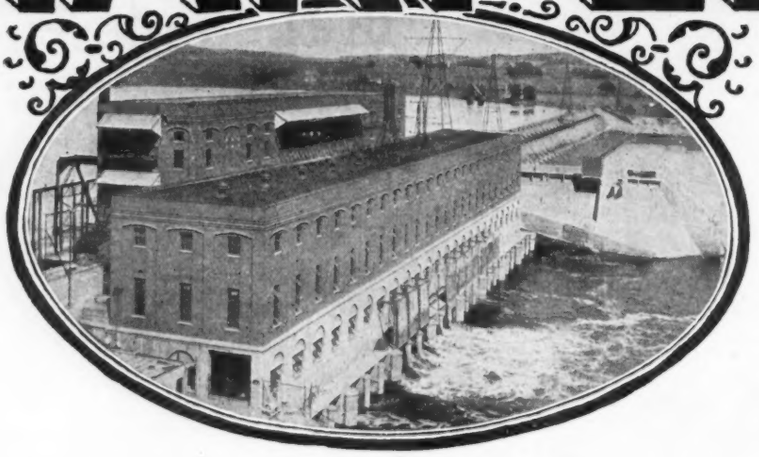
Chance
NEVER-CREEP
Anchor

That's all!

"Take a Chance for certainty"

SHARPLES

A GREAT FORCE



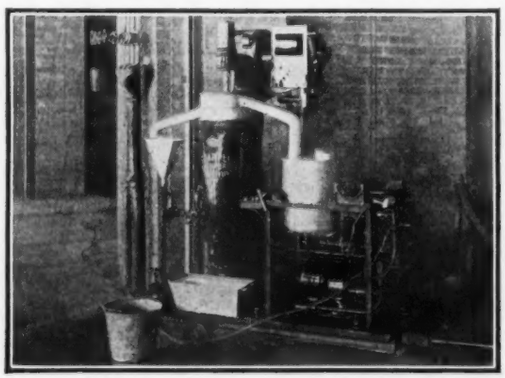
Sharples Effects Great Savings Here!

26c Per Gallon Saved in Dehydrating Transformer Oil

A Sharples Portable Super Centrifuge, recently installed for reclaiming switch and transformer oils at the large Prairie du Lac generating station of the Wisconsin River Power Company, accomplished a job of real saving that was little short of remarkable.

Placed in operation between two 25-cycle transformers, each containing approximately 2200 gallons of oil carrying a large amount of water, the Sharples Super Centrifuge completely dehydrated this oil at a cost of *approximately 1 cent per gallon.*

When previously reconditioned by filter press, the cost of reclaiming this oil was approximately 27 cents per gallon. The Sharples Process, therefore, actually effected a clear saving of 26 cents per gallon.



Mr. John A. Radlund, manager of the Wisconsin River Power Company, says:

"Our operating conditions on the 25-cycle system are such that the 25-cycle station transformers are being heated and cooled approximately twice a day, which accounts for the great amount of water absorbed by the oil. This condition is not usually found in stations, but here we have a case where the Centrifuge makes it possible, at a very low cost, to keep our oil up to its highest dielectric strength."

* * *

See the Sharples Exhibit in Booth 92, Exposition of Power and Mechanical Engineering, Grand Central Palace, New York, December 6-11, 1926.

THE SHARPLES SPECIALTY COMPANY, 2314 WESTMORELAND STREET, PHILADELPHIA. Boston, New York, Pittsburgh, Chicago, Detroit, Tulsa, New Orleans, San Francisco, Los Angeles, Seattle. London, Paris, Tokio.

The Sharples Process

Power Problems

Due to the ever-increasing demand for low rate commercial power, many old plants must now either be written off the books and replaced by entirely new ones, or modernized, in order to meet the demand. Fixed charges and operating costs, the main controlling factors upon which rates are based, must of necessity be kept at the lowest possible point, and to accomplish this, correct design is important.

We have made exhaustive studies and experiments in both steam and hydro-electric developments, have designed power plants for operation with all kinds of fuel and often developed new methods and practices for the use of special fuel.

Our many years of experience in the design, construction and rehabilitation of power plants qualifies us to design your new plant or recommend changes in your present plant or distributing system to care for new business.

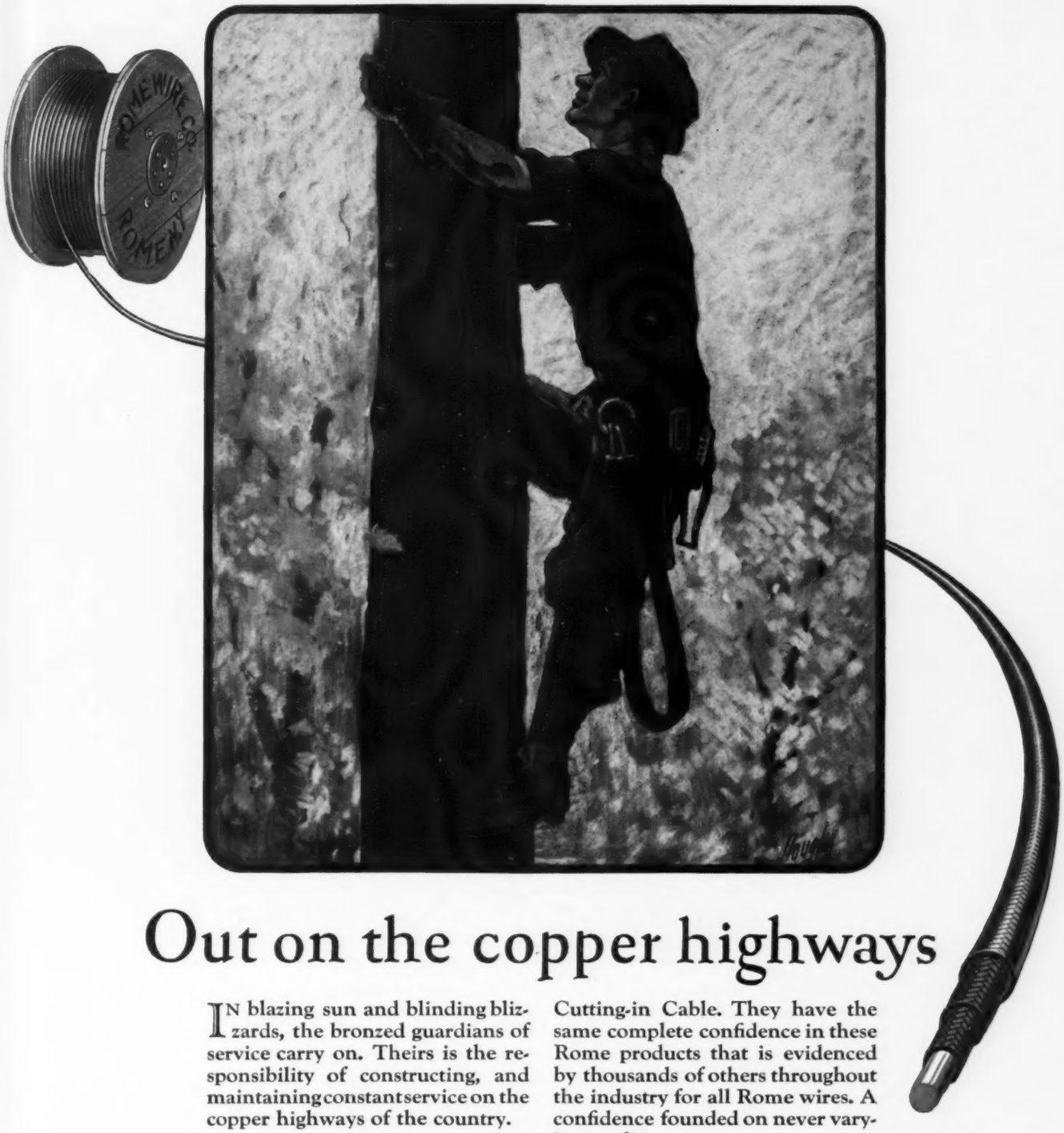
The J. G. White Engineering Corporation

Engineers
43 Exchange Place

Constructors
New York, N. Y.

32 years of uninterrupted progress and concentration on the one product

LOCKE
PORCELAIN



Out on the copper highways

IN blazing sun and blinding blizzards, the bronzed guardians of service carry on. Theirs is the responsibility of constructing, and maintaining constant service on the copper highways of the country.

Ask them about wires, if you would know the opinions of men who actually handle and work with wire. Ask, too, the engineer in charge of distribution. For he will give you the engineering viewpoint.

From both lineman and engineer you will hear only good of Rome Weatherproof Wire and Rome Cutting-in Cable. They have the same complete confidence in these Rome products that is evidenced by thousands of others throughout the industry for all Rome wires. A confidence founded on never varying quality.

In twenty years the Rome Wire Company has grown from a small wire shop to mills that cover twenty acres of manufacturing floor space. Rolling, drawing, insulating each of its many wires and cables in these mills. Justifying industry's confidence by never-ceasing inspection.

Solid Weatherproof Wire

ROME WIRE COMPANY, ROME, N.Y.

ROME WIRE

FROM WIRE BAR TO FINISHED COPPER WIRE

Antenna Wire

Weatherproof Wires and Cables

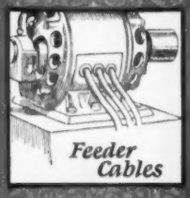
Trolley Wires and Cables

Tinned Copper Wires and Cables

Telephone Wires and Cables

Automobile Wires and Cables

Slow Burning Wires

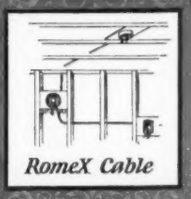

Feeder Cables

Super Service Cords and Cables

Extra Flexible Wires and Cables

Rubber Covered Wires - Code 30% Intermediate

Heater Cords

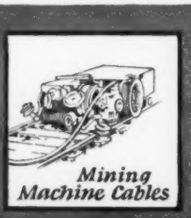

RomeX Cable

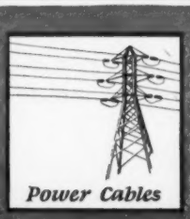
Lamp Cords

Copper Rod and Bare Copper Wire

Lead Sheathed Cables

Magnet Wire


Mining Machine Cables


Power Cables

Radio Wires and Cables

BAKED at 125° F. and frozen at 10° below zero before it is released by the inspection department—is there any wonder that Rome Weatherproof Wire stands up on the job despite blazing summers and roaring winters?

It is just such careful testing, and inspection of all Rome Wires and Cables, that has built their reputation for quality thruout the electrical industry. Backed by the facilities of twenty acres of manufacturing floor space, bettered by the judgments of twenty years of manufacturing experience, every Rome Wire stands out as a quality product.

If you will let us know what wires and cables, shown on this page, you are interested in, we will be glad to send you samples, catalogs, and other information that will be of help to you—while an opportunity to quote on any of your wire requirements will always be welcome.

Rome-Wire

ROME WIRE COMPANY

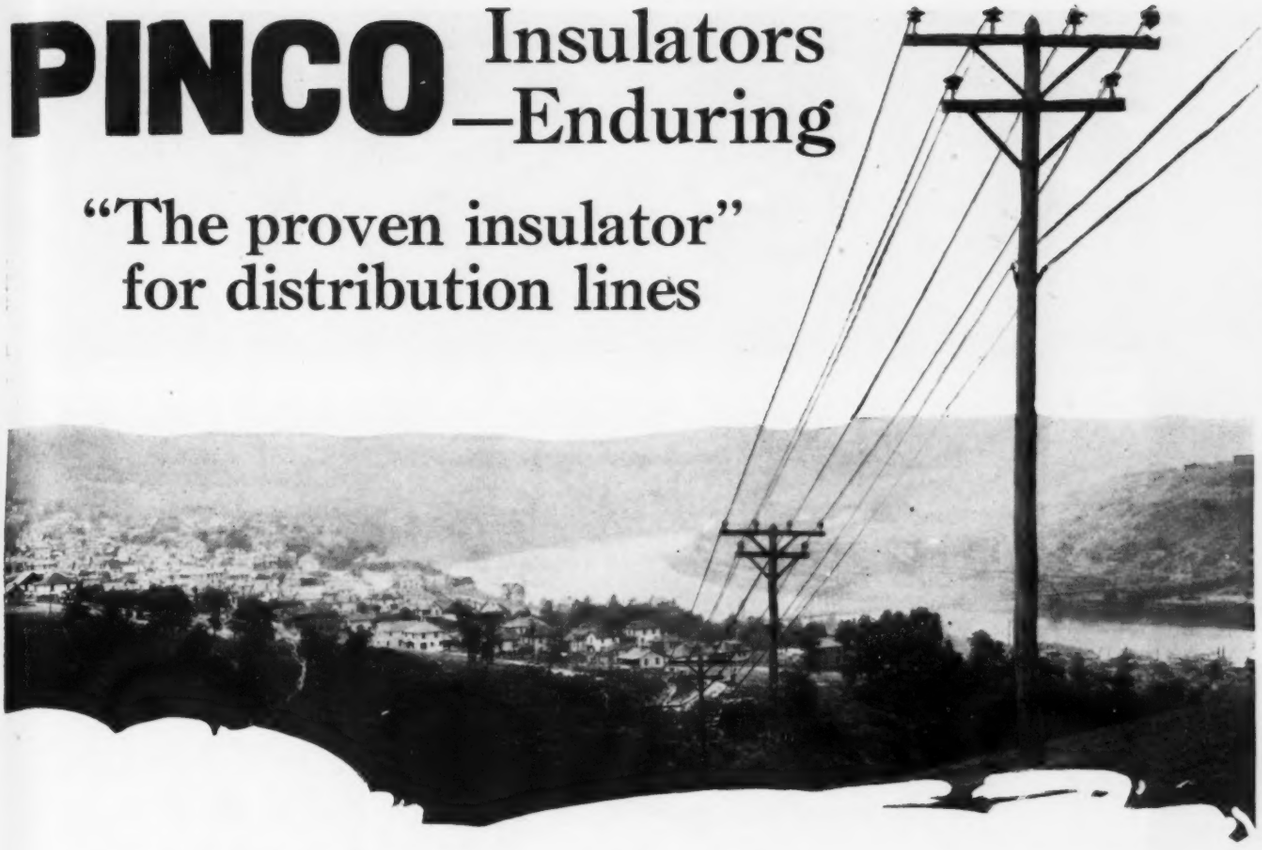
Mills and Executive Offices: ROME, N.Y.

Diamond Branch: Buffalo, N.Y.

New York — 50 Church Street
Boston — 1011 Little Building
Chicago — 14 E. Jackson Blvd.
Detroit — 25 Parsons Street
Cleveland — 1200 W. 9th Street
Los Angeles — J. G. Pomeroy, Inc., 336 Azusa Street
San Francisco — J. G. Pomeroy, Inc., 51 Federal Street

PINCO Insulators —Enduring

"The proven insulator" for distribution lines

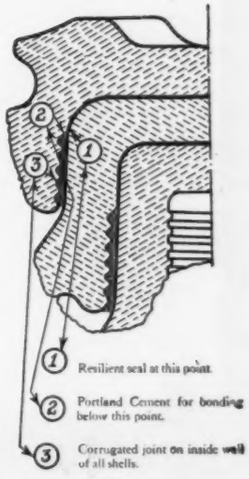


The West Penn Power Co. is called upon to serve many important customers, customers who must have electric energy at all times. PINCO No. 75 insulators are helping them to furnish their customers with this continuous service, although some of their lines run through sections subject to violent electrical storms.

The above photograph shows one of the many dependable lines of the West Penn Power Co. insulated with PINCO No. 75's.

PINCO insulators do not depend upon a solid, unyielding joint to hold the parts together. A resilient feature at the critical section of the cement joint absorbs the stresses set up by expansion and contraction due to temperature variations and cement growth. Even the intense heat of flashovers fails to break the insulator.

PINCO pin type insulators are made in voltages up to 90,000. We invite your investigation. Write

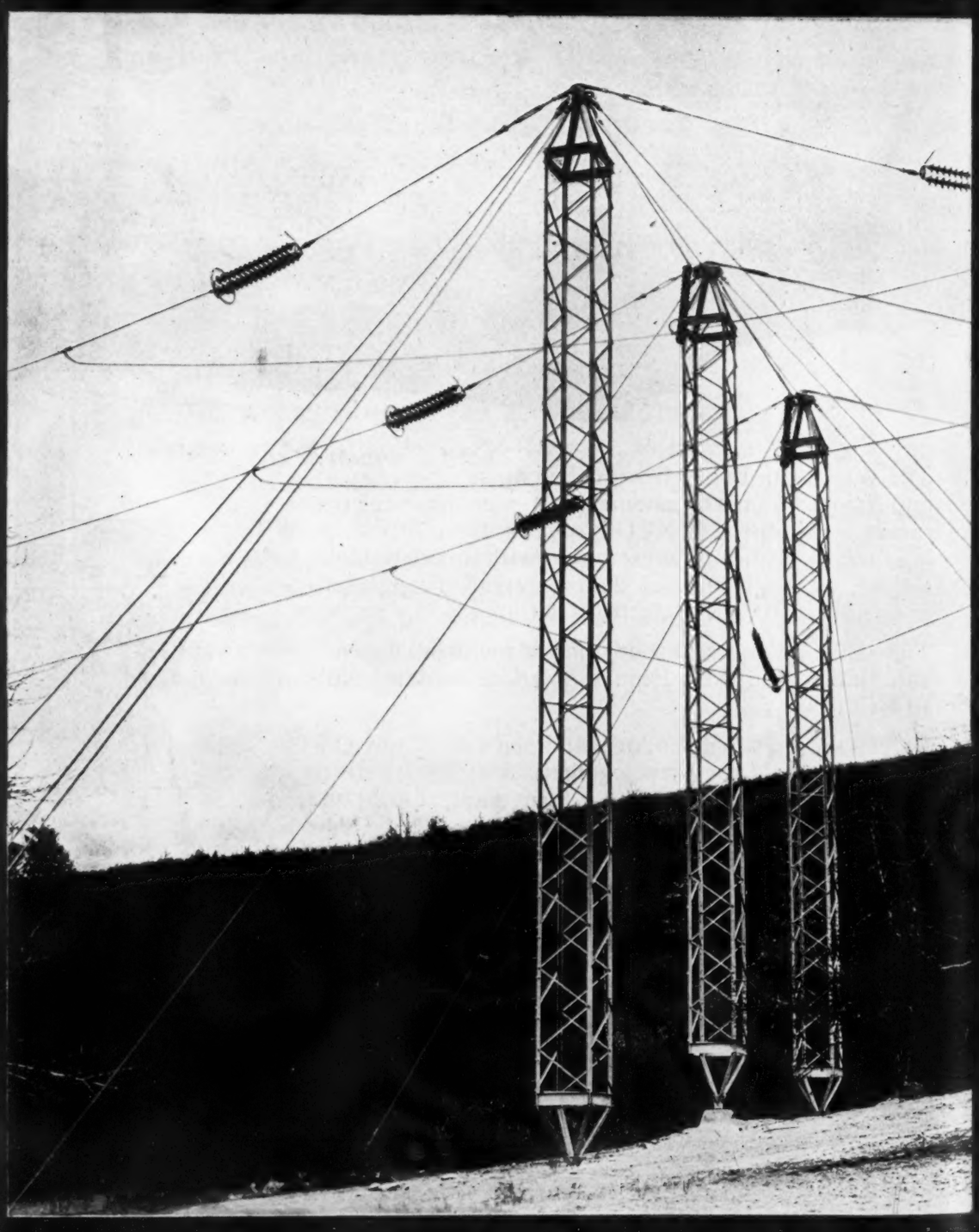

1 Resilient seal at this point.
2 Portland Cement for bonding below this point.
3 Corrugated joint on inside wall of all shells.

THE PORCELAIN INSULATOR CORPORATION
LIMA, NEW YORK

Exclusive Distributors in the United States

BAKER-JOSLYN
San Francisco
DETRICK-JOSLYN
Los Angeles
AMERICAN JOBBERS SUPPLY CO.
New York City
Boston
Philadelphia
Baltimore
Savannah
SOUTHERN JOBBERS SUPPLY CO.
New Orleans
JOSLYN MFG. & SUPPLY CO.
Chicago
Kansas City
Cincinnati
Pittsburgh
JOBBERS SUPPLY COMPANY
St. Paul
Seattle
Portland

A.C.S.R.



for 222,000 volts

Pennsylvania Power & Light Company's Wallenpaupack-Siegfried Line

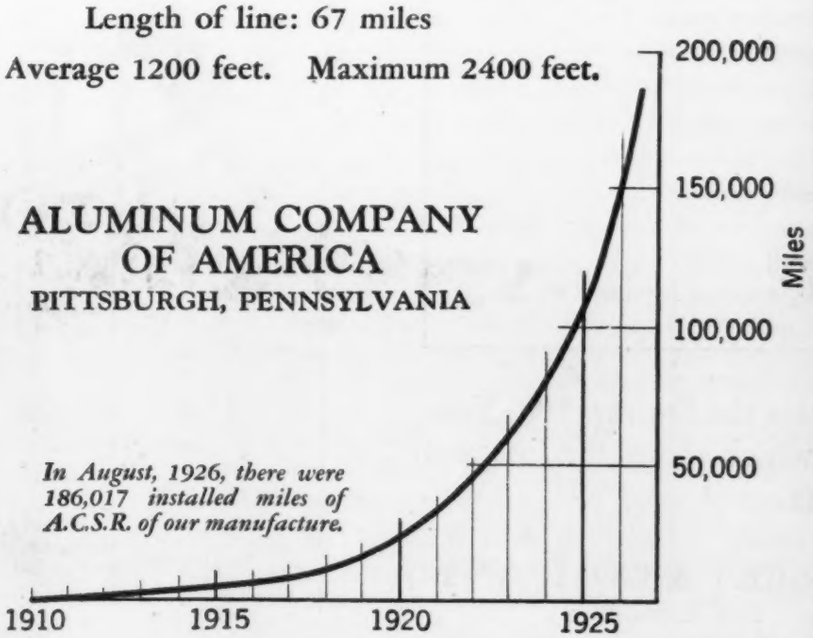
A NOTABLE line built to withstand severe winter conditions with heavy wind and ice loads. A.C.S.R. is the conductor used—strong, light in weight and dependable under severe conditions.

Conductor = 795,000 A.C.S.R. { 54 strands .1214" aluminum / 7 strands .1214" steel

Length of line: 67 miles

Spans: Average 1200 feet. Maximum 2400 feet.

ALUMINUM COMPANY OF AMERICA
PITTSBURGH, PENNSYLVANIA



In August, 1926, there were 186,017 installed miles of A.C.S.R. of our manufacture.

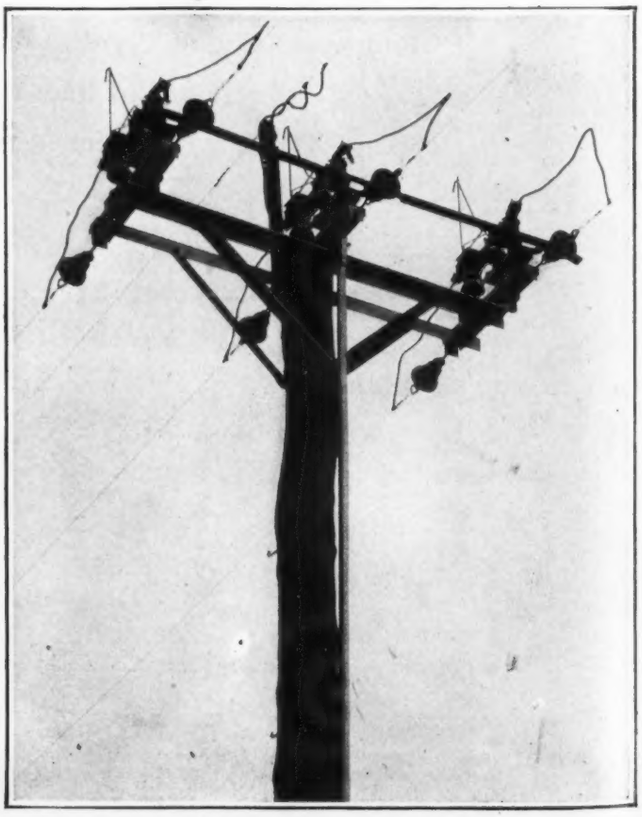
Another DOSSERT SERVICE . .

On Construction

—here are a lot more services in generation, transmission and distribution equipment on which DOSSERTS save your time and money.

. . on the lines of the Atlantic City R.R. . . . Reading System at Camden, N. J.

Dossert Cable Taps used to connect the horn gap disconnecting switch leads to the power lines.



Connecting cables, stranded or solid wires, rods and tubing.

Connecting two conductors of same size or different sizes.

Connecting wires to cables, cables to rods or tubing.

Connecting conductors at right angles.

Making three-way splices at right angles or other angles or with wires parallel.

Connecting branch circuit to main circuit.

Connecting one or two conductors to lug direct or at an angle.

Connecting wires to studs.

Connecting one or two cables to anchor.

To equalize load on two feeders.

Connecting to service boxes and cutouts.

Connecting grounds.

Connectors for all iron pipe sizes of tubings.

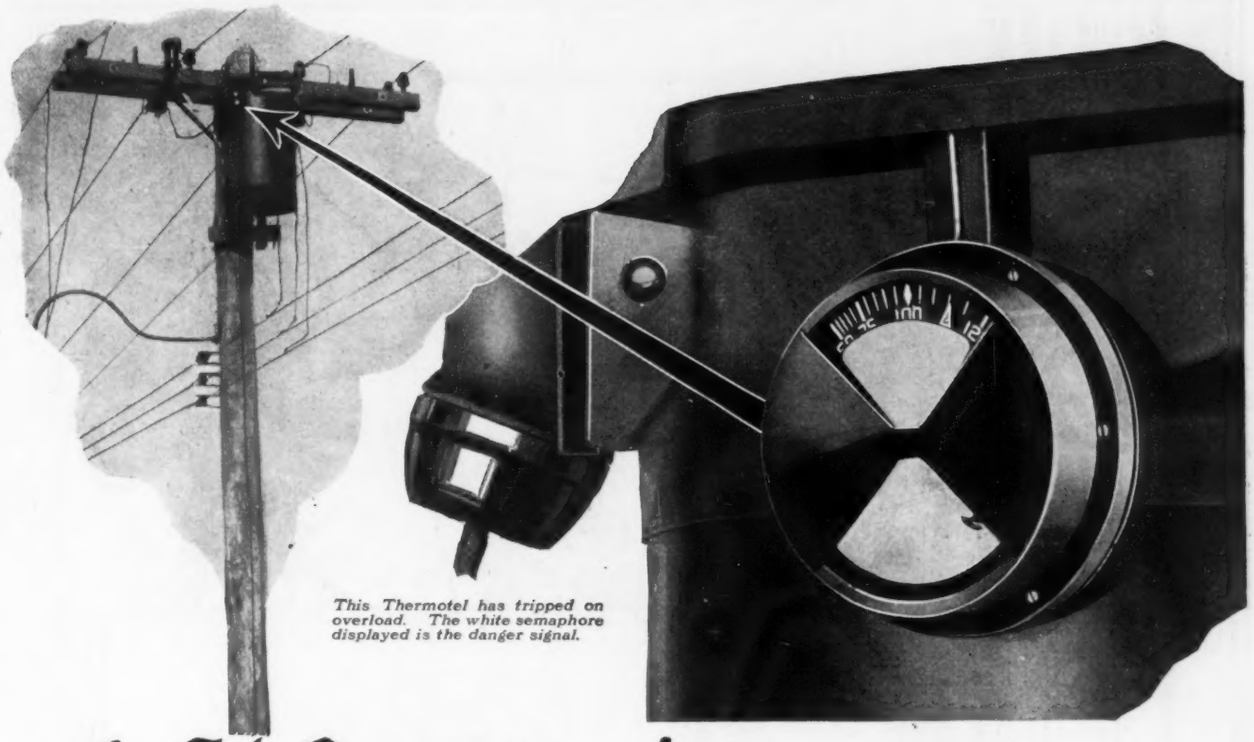
Special connectors for special services.

Write for the Dossert 20th Year Book which shows the line and the data.

DOSSERT & COMPANY

H. B. Logan, Pres.

242 West 41st St. *New York, N. Y.*



This Thermotel has tripped on overload. The white semaphore displayed is the danger signal.

A Warning!

Meet the December peak with Thermotels

With more motors, heating appliances, and lamps constantly being connected, how can you know accurately your transformer loads from office records? Put a Thermotel on each transformer before the December peak comes on and have

—readings of maximum loads, direct in terms of continuous output;
—these readings automatically corrected for ambient temperature;
—danger signals when overloads are reached;
—under-load readings as well as over-load;
—existing load when you re-set instrument.

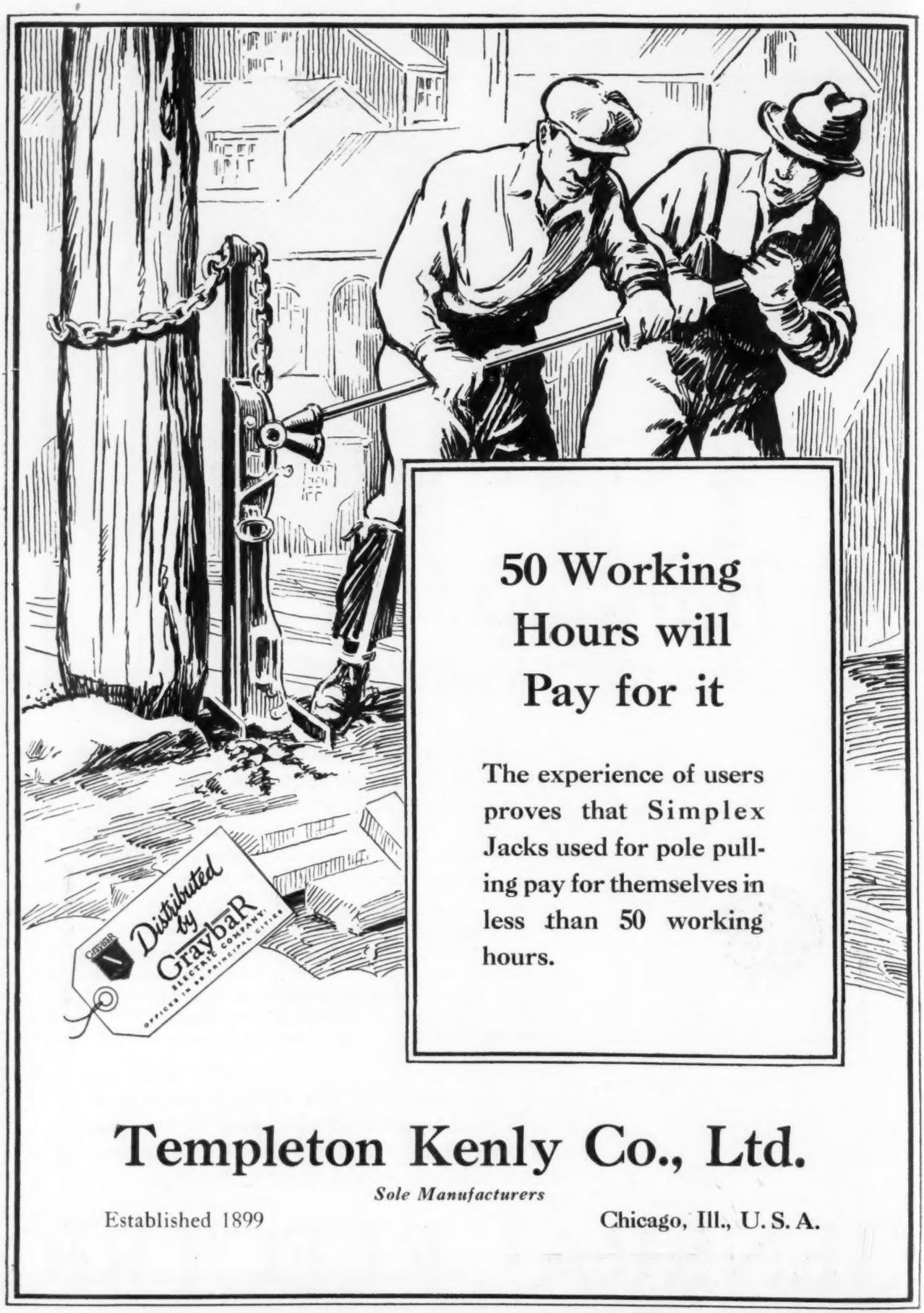
Remember that Thermotels will help you avoid the results of low voltage from overloaded units—poor service, loss of revenue, shortened transformer life—and *possibly* complete interruption of your service.

The Thermotel (Cat. No. 270503) is a G-E instrument recently introduced to make transformer load surveys more reliable and economical. It is easily installed and suitable for a wide range of G-E pole type and subway Transformers. Bulletin GEA-309 contains full information.

405-6

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y., SALES OFFICES IN PRINCIPAL CITIES



50 Working Hours will Pay for it

The experience of users proves that Simplex Jacks used for pole pulling pay for themselves in less than 50 working hours.

Templeton Kenly Co., Ltd.

Sole Manufacturers

Established 1899 Chicago, Ill., U. S. A.

SANDERSON & PORTER
Engineers

Organize, Manage, Operate and Finance
PUBLIC UTILITIES and INDUSTRIALS

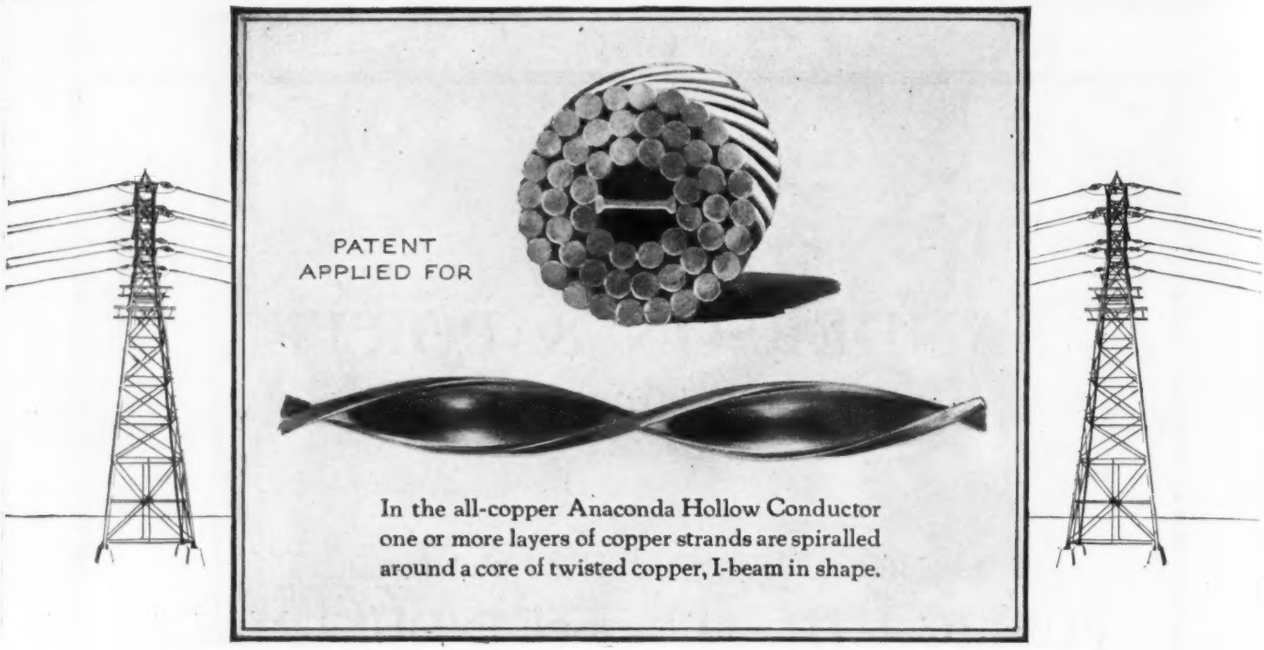
Design and Construct

Transmission and Distribution Systems
Hydro - Electric Power Developments
Water Supply and Irrigation Works
Power Stations and Sub-Stations
Industrial Plants and Buildings
Oil and Gas Properties
Electric Railways
Oil Pipe Lines

NEW YORK
52 William Street

CHICAGO
231 South LaSalle Street

SAN FRANCISCO
14 Montgomery Street



In the all-copper Anaconda Hollow Conductor one or more layers of copper strands are spiralled around a core of twisted copper, I-beam in shape.

ANACONDA HOLLOW CONDUCTORS

reduce corona loss economically

THE Anaconda Hollow Conductor Cable is an epoch-making development for transmission lines carrying high voltages or large currents.

It provides a durable all-copper conductor light in weight, high in conductivity and tensile strength, and easily adapted to any given transmission requirement.

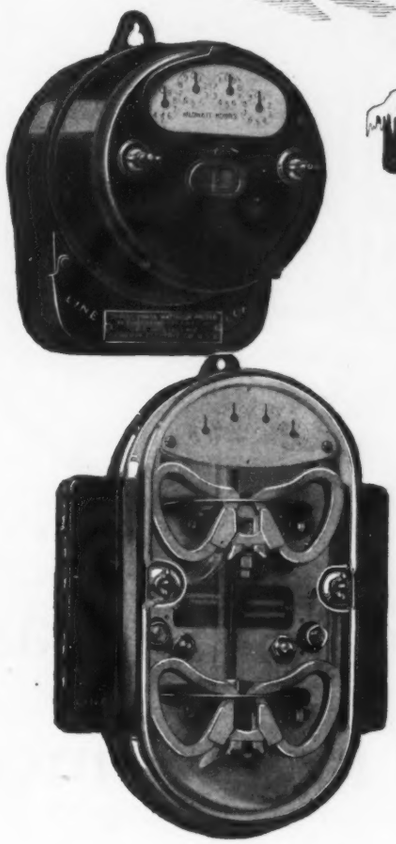
Electrical engineers are invited to investigate the advantages of the Anaconda Hollow Conductor for their power transmission work. May we send Research Bulletin C-6?

ANACONDA COPPER MINING CO.
THE AMERICAN BRASS COMPANY
Rod, Wire and Cable Products
General Offices: 25 Broadway, New York
Chicago Office: 111 W. Washington St.

ANACONDA COPPER

BRASS ANACONDA from mine to consumer BRONZE

Accurate in any temperature



TROPICAL sun or zero weather—it's all the same to G-E Watthour Meters. With the new temperature-compensation feature, G-E Watthour Meter accuracy under normal operating conditions is unaffected by heat or cold.

This means that G-E Watthour Meters register normally regardless of geographic location.

It means that power company and power consumer can expect accurate readings from G-E Outdoor Metering Outfits in any season.

It means that a G-E Test Meter taken any day and in any season to a consumer's premises will operate with the same high accuracy as in the laboratory.

These advantages constitute real benefits to the average operating company—and they have been obtained by a modification so simple as to be readily incorporated in any standard G-E alternating-current Watthour Meter.

Temperature compensation is another characteristic added to the many that have contributed to the remarkably high, long-sustained accuracy for which G-E Watthour Meters are noted.

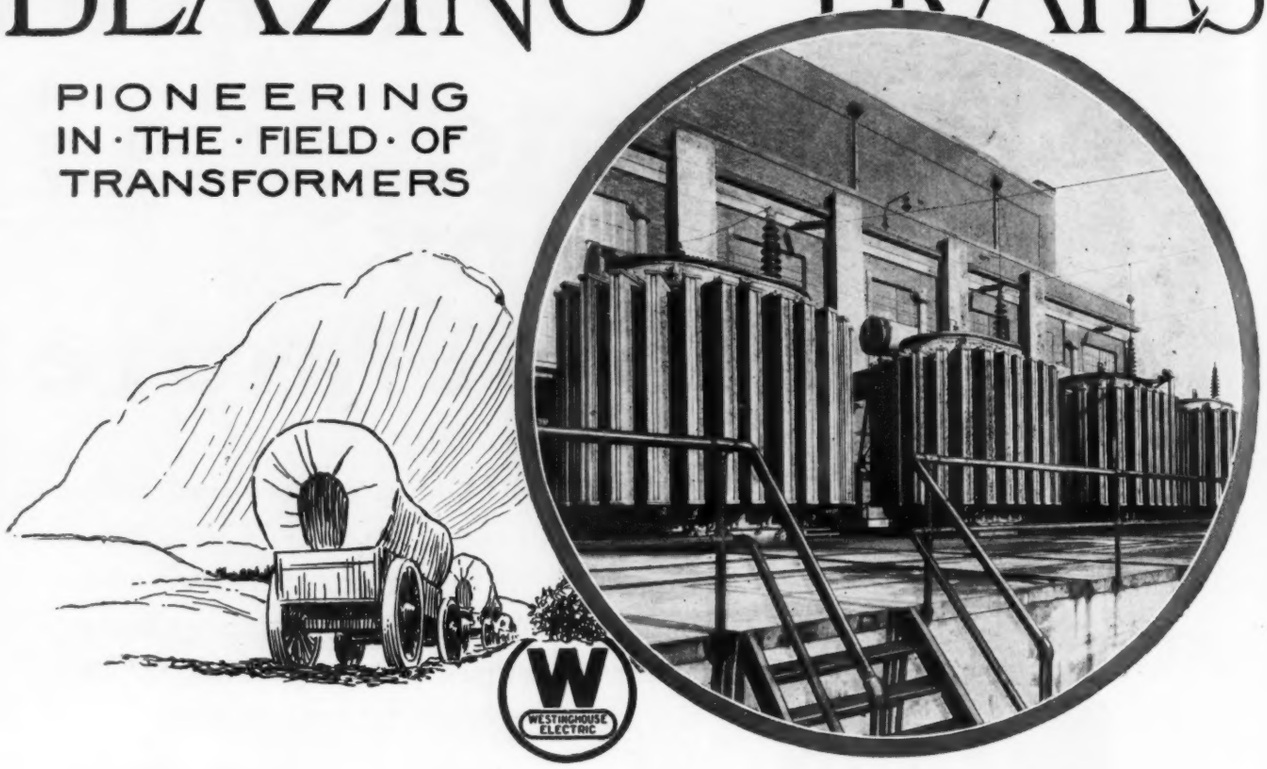
680-4

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y., SALES OFFICES IN ALL PRINCIPAL CITIES

BLAZING · TRAILS

PIONEERING
IN · THE · FIELD · OF
TRANSFORMERS



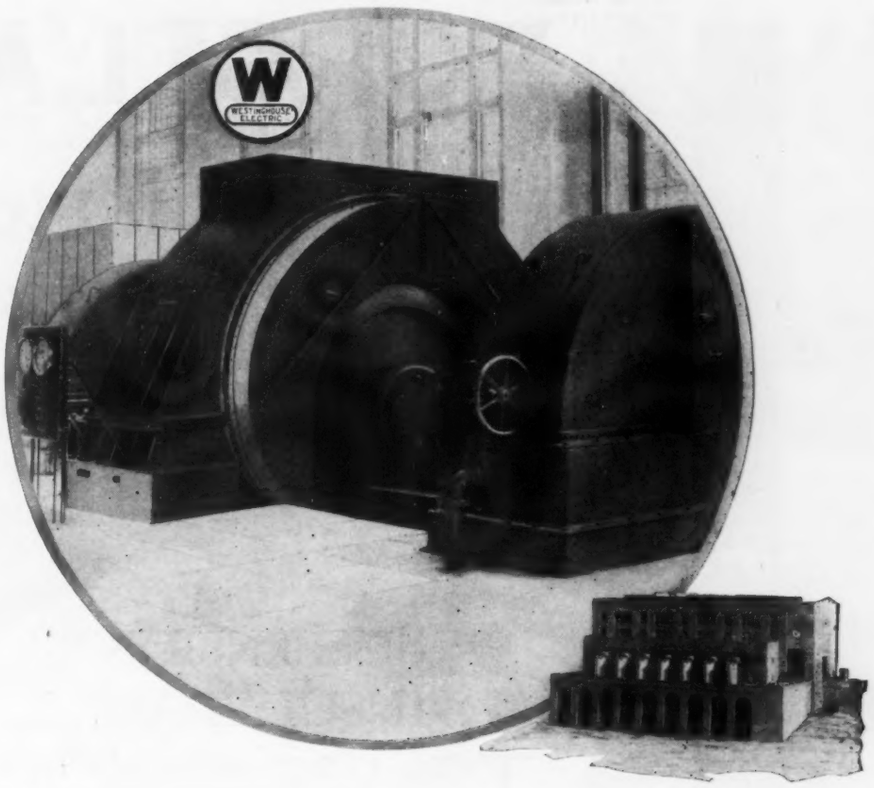
The Largest Single-Phase Self-Cooled Transformers

THE largest single-phase, self-cooled transformers in the world were built by Westinghouse for the Northern States Power Company. These are 120,000-volt O.I.S.C. with a maximum rating of 18,750 kv-a.—another example of Westinghouse leadership in transformers.

Westinghouse Electric & Manufacturing Company
Sharon Works Sharon, Pa.
Sales Offices in All Principal Cities of
the United States and Foreign Countries

Westinghouse

X90002



CONFIDENCE

- - - Born of Experience

SOUTHERN California Edison Company has just placed an order for two more record breaking Westinghouse Generators—45,000 kv-a. at 50 cycles—to take their place on the Big Creek System beside the 28,000 kv-a. 50 cycle generator shown above. Southern California Edison's confidence in Westinghouse Equipment is based upon experience. Westinghouse generators of today are the consummation of forty years of engineering and pioneering; they embody every development of forty years of constant research for greater efficiency and economy. Yet through every step of generator development, from the earliest machine to the present day, Westinghouse dependability has won friends whose constantly growing confidence is based upon more than satisfactory experience.

Westinghouse Electric & Manufacturing Company
East Pittsburgh Pennsylvania
Sales Offices in All Principal Cities of the United States and Foreign Countries

Westinghouse

X90042

PORCELAIN

You can install —*and forget*

No. 601
Average Ultimate
11,500 Pounds

No. 641
Average Ultimate
11,500 Pounds

No. 631
Average Ultimate
20,000 Pounds

No. 633
Average Ultimate
30,000 Pounds

SUSPENSION INSULATORS

THE growth of super-power transmission lines brought higher and higher voltages, constantly lengthening spans, and ever larger conductors. The ceramic industry was put to a test to produce insulators that would support the loads demanded of them.

The problem presented could not be solved by tradition, precedent, or custom. A new trail was necessary, the task of a research engineer.

Westinghouse standard suspension (No. 601) now has a rated ultimate strength of 11,500 pounds. The higher strength insulators, No. 631 and No. 633, have rated ultimate strengths of 20,000 and 30,000 respectively. Such strengths were undreamed of a few years ago.

By reason of Westinghouse leadership in the engineering development of porcelain insulators, you can have confidence in the Westinghouse insulators on your lines. You can safely forget them.

Westinghouse Electric & Manufacturing Company
Westinghouse High-Voltage Insulator Works
Derry, Pa. Emeryville, Cal.
Sales Offices in All Principal Cities of
the United States and Foreign Countries

W WESTINGHOUSE ELECTRIC

Westinghouse

X87268

FRAHM Vibrating-Reed FREQUENCY METERS

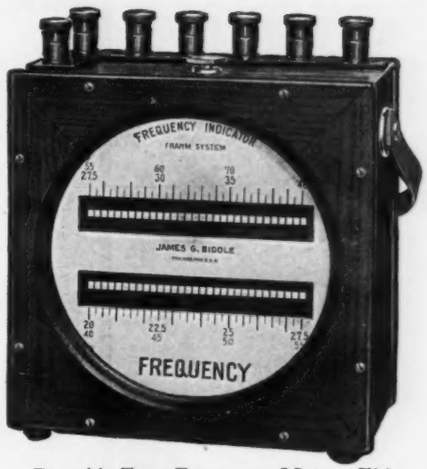
are the only Frequency Meters which contain no pivots, jewels or rotating parts.

They are unaffected by temperature or by wave-form. They operate indefinitely without losing calibration.

Absolutely different from all other electrical instruments, Frahm Frequency Meters perform a service fundamental to industry—that of indicating frequency in cycles per second. They are used in power plants everywhere—with records of fifteen years continuous service not unusual.

Engineers *who know* specify Frahm Frequency Meters, and to the best of our knowledge and belief they are the *only* frequency meters specified *irrespective* of the type or make of other instruments (ammeters, voltmeters, etc.) of which installations consist.

Bulletin 1110-W fully describes and illustrates Frahm Frequency Meters. Write today for your copy.



Portable Type Frequency Meter. This is the Frequency Standard for hundreds of Power Companies and Industrial plants, large and small, throughout the United States. Covers a wide range, e.g. from 27.5 to 80 cycles as shown.

Switchboard type Frahm Frequency Meter for 60 cycles. Available for frequencies as low as 15 and as high as 120 cycles with both one and two rows of reeds.

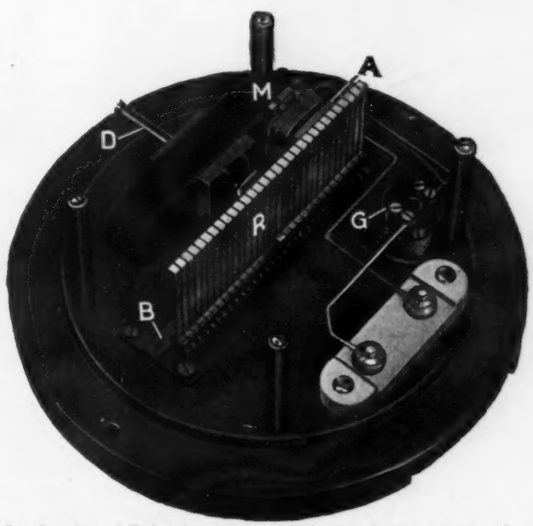
JAMES G. BIDDLE

Electrical Instruments

1211-13 Arch Street, Philadelphia, Pa.

BIDDLE SPECIALTIES

- "Megger" Insulation Testing Instruments
- Frahm Frequency Meters
- Frahm Tachometers
- Speed Measuring Instruments
- Jagabi Rheostats
- Dionic Water Tester
- Siemens & Halske Precision Electrical Instruments
- "S-H" Standardizing Set
- Precision Potentiometers
- Scientific Apparatus



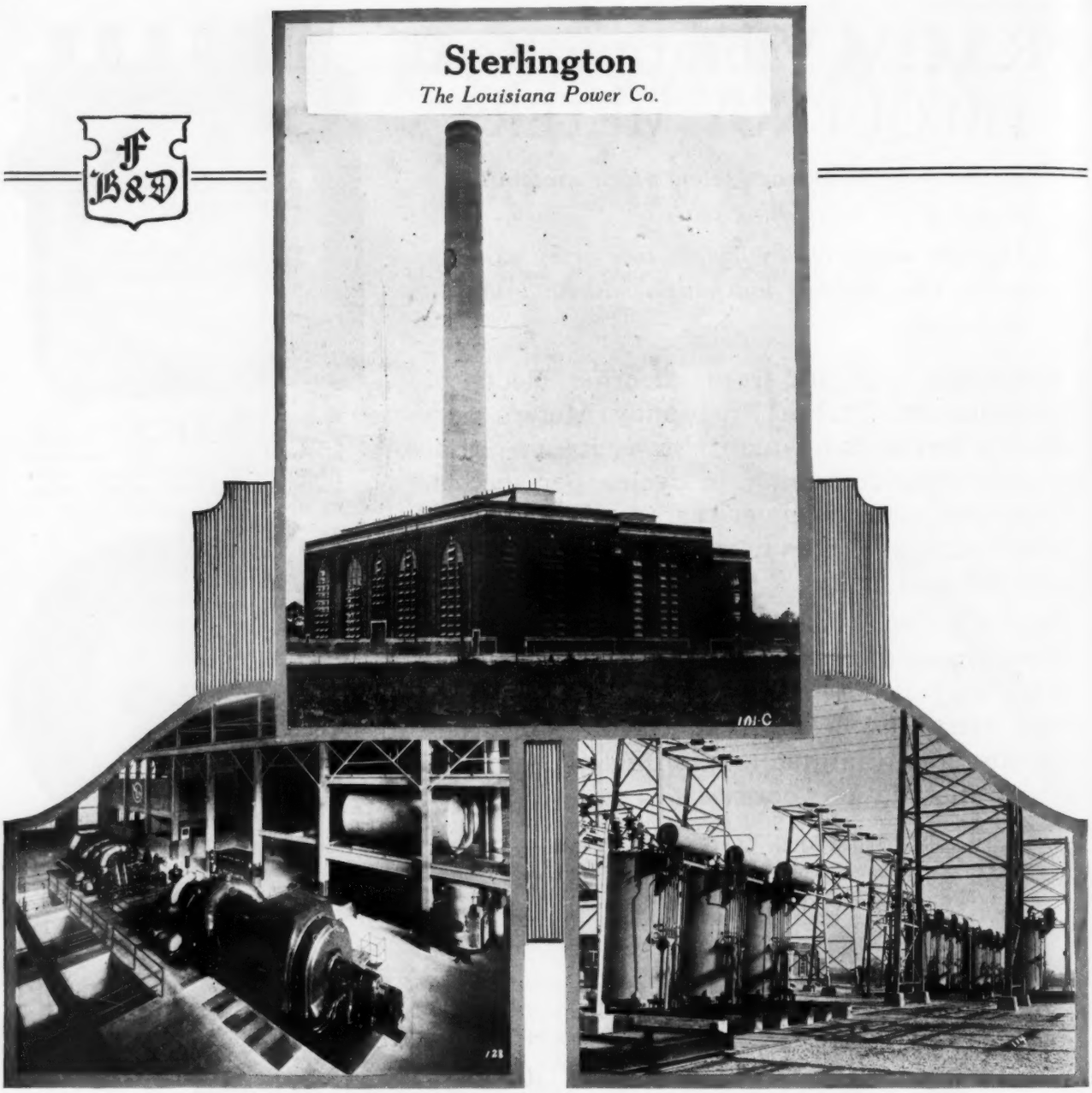
Interior view of Frahm frequency meter, showing details of construction.

A—Armature of the electromagnet M.
B—Bridge-piece on which are mounted the reeds R. Armature A also is mounted on B.
D—Amplitude adjusting screw by which the air-gap between A and M is set.
G—Protective series resistance for M.
M—Electromagnet.
R—Tuned reeds, each one of which is adjusted to respond by resonance to a given mechanical vibration set up in B through A by the alternating current in M.

F B&D

Sterlington

The Louisiana Power Co.



A pioneer natural gas fired plant

The new Sterlington Steam Plant of The Louisiana Power Company, is of particular interest to every power plant man for three reasons.

First, it represents a unique idea—the utilization of a natural gas field, which had been considered unsuited to such a purpose.

Second, it embodies many original engineering developments necessitated by the conditions under which it was built, and must operate.

Finally, it has proved so successful in operation that it is now producing power at a lower total cost per kw.-hr. than any other steam power plant in the country.

Sterlington is typical of the original and progressive engineering thought which has always characterized the service rendered by our organization to Industry and the Utilities.

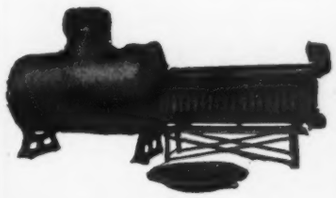
New York
San Francisco
Chicago

Ford, Bacon & Davis
Incorporated
Engineers

Philadelphia
New Orleans
Monroe, La.

Get rid of scale *before* it enters the boilers

There's a G-R Evaporator for every type of plant

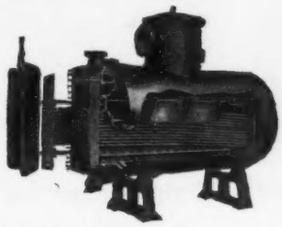


Reilly Evaporator, Horizontal Steel Shell Type

For high or low pressures. The patented self-scaling feature is provided by the spring-shaped coils which distort with temperature changes, effectively cracking off the accumulated scale.

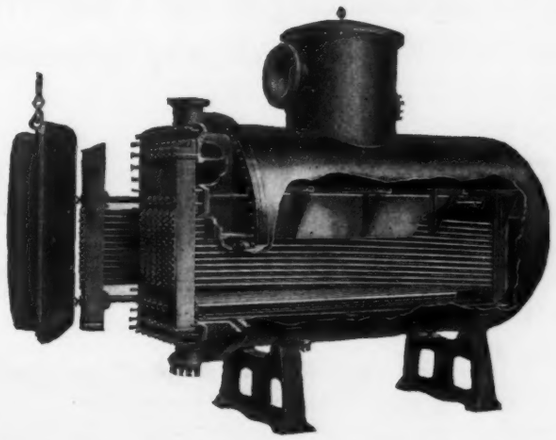
Reilly Evaporator, Vertical Cast Iron Type

Built for high pressure. Similar in arrangement to the horizontal steel shell type and with the same self-scaling features. For smaller capacities.



G-R Bentube Evaporator

For plants where an exhaust steam evaporator system is preferred. In this type, bowed steam tubes are used in which the increased deflection caused by temperature rise causes accumulated scale to crack off.



Did you ever figure how much money scale is costing you each month—in fuel-wasting boiler blows, in idle investment and labor cost during tube-cleaning periods?

You can eliminate all these expenses—and secure other benefits besides—by installing a

G-R EVAPORATOR

(self-scaling)

By distillation, this apparatus supplies absolutely pure boiler feed make-up from any source of dirty, hard or salty raw water. No chemicals are used, the action is entirely automatic, and the evaporator is kept free from scale by the special construction of the tubes.

Greater cleaning capacity, lower fuel costs, and higher boiler safety—these are the benefits of a G-R Evaporator installation.

Send the coupon for full information

The Griscom-Russell Co., Dept. B, 285 Madison Ave. New York

Philadelphia	Chicago		St. Louis	San Francisco
Boston	Cleveland		New Orleans	Los Angeles
Rochester	Detroit		Houston	Seattle
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Columbus	Minneapolis		Atlanta	Salt Lake City
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For Canada: Riley Engineering & Supply Co., Ltd., Toronto

Griscom-Russell

Heat Transfer Apparatus

Send me at once without charge copy of your booklet on boiler feed purification by distillation

The Griscom-Russell Co., Dept. B, 285 Madison Ave., New York

Name .....

Company .....

Address .....

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Specializing in the Underwriting and Distribution of Securities of

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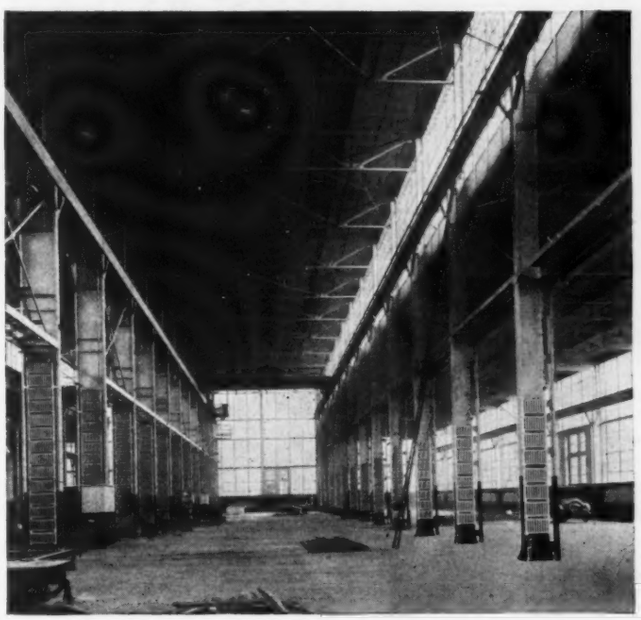
In addition, through affiliated private wire systems, we reach all other important cities in the United States and Canada.

When Days Count —

When you get ready to build, every day that can be saved in designing and building is a day of profit for you.

Under the Austin Method a building project that would ordinarily take six months to complete is finished in sixty to ninety working days.

Scores of Austin Plants all over the United States testify to the unusual experience which this Company has had.



Interior of the erecting shop of the Pittsburgh Transformer Company, Pittsburgh, designed, built and equipped by Austin

You sign only one contract when you deal with Austin. That covers everything — architectural service, engineering, construction and equipment. No division of responsibility. No pyramiding of profits as with sub-contracts. Austin guarantees the total cost in advance for the complete plant; delivery date, with bonus and penalty clause if preferred; and quality of materials and workmanship.

Austin Plants are the standard for the electrical industry, and executives are more and more turning to Austin for this specialized engineering and building service. When days count, Austin saves months, and furnishes a plant that represents the most up-to-date design.

Wire, phone or mail the coupon for approximate costs and valuable building data.

THE AUSTIN COMPANY, *Engineers and Builders,* CLEVELAND

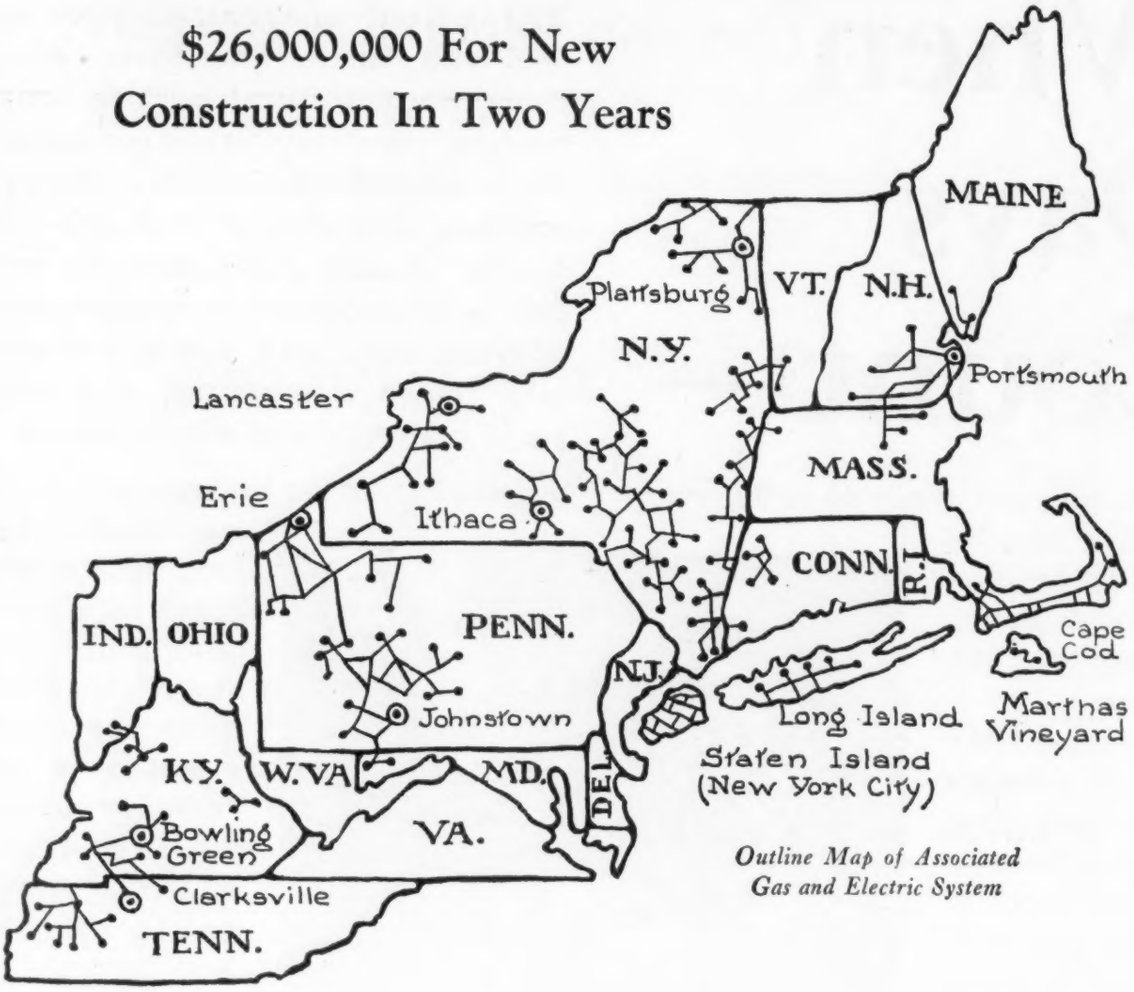
New York, Cleveland, Chicago, Detroit, Philadelphia, Portland, Seattle, Miami, Birmingham, Pittsburgh, St. Louis
The Austin Company of California: Los Angeles and San Francisco.
The Austin Company of Texas: Dallas.

AUSTIN

Complete Building Service

THE AUSTIN COMPANY, Cleveland
We are interested in the erection of a _____ Building
_____ x _____, number of stories _____
You may send me a personal copy of "The Austin Book of Buildings," free to Industrial Executives.
Firm _____
Individual _____
Address _____
E. W. 9-26

$26,000,000 For New Construction In Two Years



Outline Map of Associated Gas and Electric System

The Associated System has a new high record in serving at the present time 350,000 customers. As a result it has been necessary to expand considerably its generating and distributing facilities.

$17,000,000 was spent during 1925 for construction of new transmission lines, substations and additions to power plants. $9,000,000 is being spent for these purposes in 1926.

During the first seven months of the present year the Associated properties have shown an average increase in the output of electricity over the same period for the preceding year of approximately 18%.

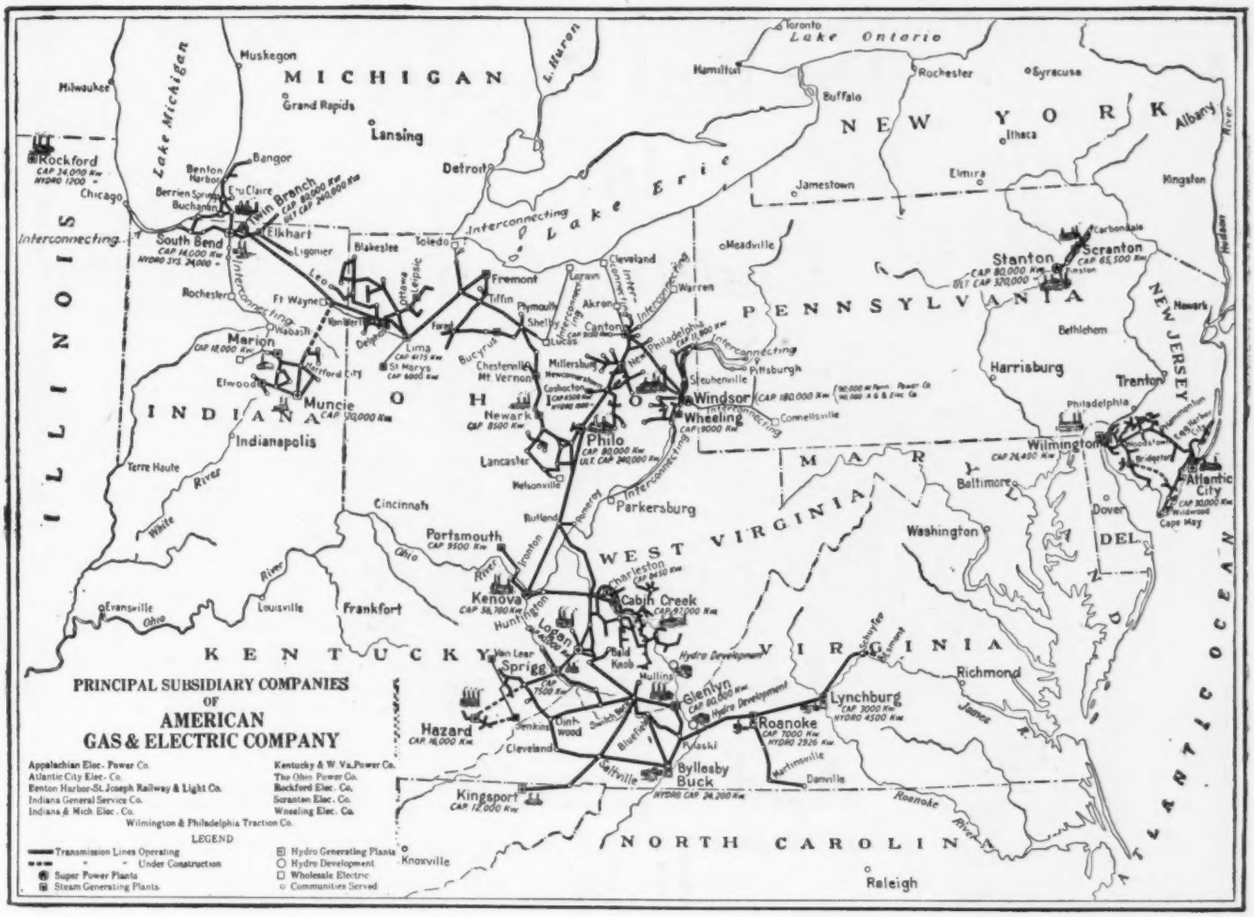
This growth is the result of the successful manner in which the management of the Associated properties has been able to supply the needs of the communities served.

ASSOCIATED GAS & ELECTRIC SYSTEM

Associated Gas and Electric Company

61 Broadway New York City

American Gas and Electric Company



1906—1926

TWENTY YEARS OF PUBLIC SERVICE

Beginning in a group of five single communities and now extending to over seven hundred communities in eleven states, the American Gas and Electric Company has, with its twenty-nine operating subsidiaries, been able to render dependable service at uniformly low cost to its ever-increasing number of customers. It serves and has been in no small way responsible for the rapid growth of one of the richest industrial territories in this country. To aid in that growth, American Gas and Electric Company has erected new super-power generating plants rated among the most economical and efficient, and designed to render maximum service at minimum cost.

It has developed one of the largest super-power systems in the world, extending through Michigan, Indiana, Ohio, Kentucky, West Virginia and Virginia, and interconnecting by means of high voltage transmission trunk lines its large modern steam electric generating stations and water power developments, thus insuring to the highly diversified industries which it serves a continuous, dependable supply of power wherever and whenever needed. Its expansion program is planned always to anticipate, never to follow, its customers' needs.

American Gas and Electric Company

30 Church Street **NEW YORK**

The Best Practice In Construction Is No Different From The Best Practice In Financing And Operating It Is The Practice Of Honesty

"All Your Money—All The Time—On Time"

W.B. FOSHAY CO.

(INCORPORATED)

Foshay Building

Minneapolis

New York Chicago Denver St. Paul Portland, Ore.

30 Carloads for Santiago, Chile

The Largest Foreign Order for Ornamental Lamp Standards Ever Placed

This train of thirty cars leaving the plant of The Union Metal Manufacturing Company carries part of the largest order of ornamental lamp standards ever placed.

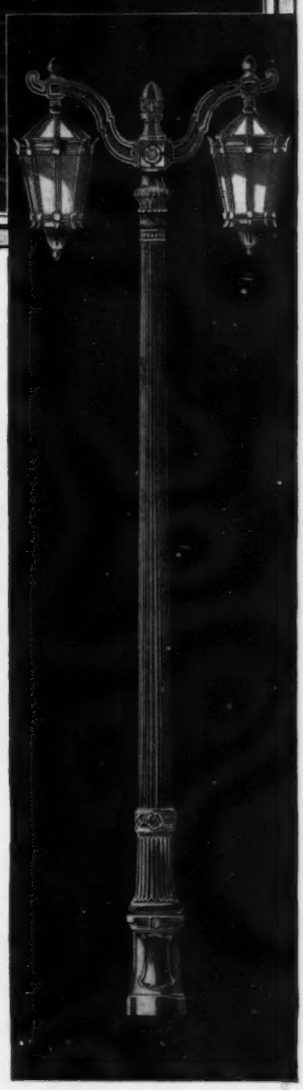
These standards—5,000 of them—are to be erected in Santiago, Chile, and will make that city one of the best lighted cities in the world.

Once again—Union Metal through the agency of The International General Electric Co. has demonstrated the ability to suggest "The Right Way for Your White Way." The experience gained through this and thousands of other installations is yours for the asking.

This Book No. 52 — "Better Street Lighting" — should be in the hands of everyone interested in making streets brighter, safer and more beautiful. Mailed free upon request.

THE UNION METAL MANUFACTURING CO.
General Offices and Factory, Canton, Ohio
Chicago Office—230 South Clark Street

UNION METAL
LAMP STANDARDS



Union Metal Design No. 2434 equipped with two General Electric Form 19B Novalux Lanterns. Five thousand of these will be used in the Santiago installation.

PEMCO PRODUCTS

TROLLEY BRACKET

The above CUT shows a NEW TROLLEY BRACKET which is so designed that the FIXTURE will always hang VERTICAL regardless of the ANGLE of the POLE. It also contains a SHOCK ABSORBING DEVICE that takes up all the VIBRATION thus preventing the LAMP from coming UNSCREWED or the BREAKING of the FILAMENT.

MADE IN TWO SIZES 22 in. and 31 in. EXTENSION.

Further details upon request.

PHILADELPHIA ELECTRICAL AND MANUFACTURING COMPANY
1228-36 North Thirty-first Street, Philadelphia, Pa.

Exceptional Construction and Operating Features important to **Central Stations**

ESSCO Traffic Control SYSTEMS

The Essco Mfg. Co. offers a specialized traffic control service which incorporates not only the manufacture of guaranteed traffic control equipment but the scientific application of that equipment to traffic conditions wherever they may be. Essco "Stop and Go" traffic lights are effectively guiding traffic in many large cities as well as small towns.

Important considerations for Central Stations are the facts that Essco units are easily installed, give service with minimum maintenance, and are easy to inspect. This has all been proven by actual and long installations.

MUSHROOM TRAFFIC LIGHTS

Equally conspicuous by day or night.

No emergency servicing is necessary.

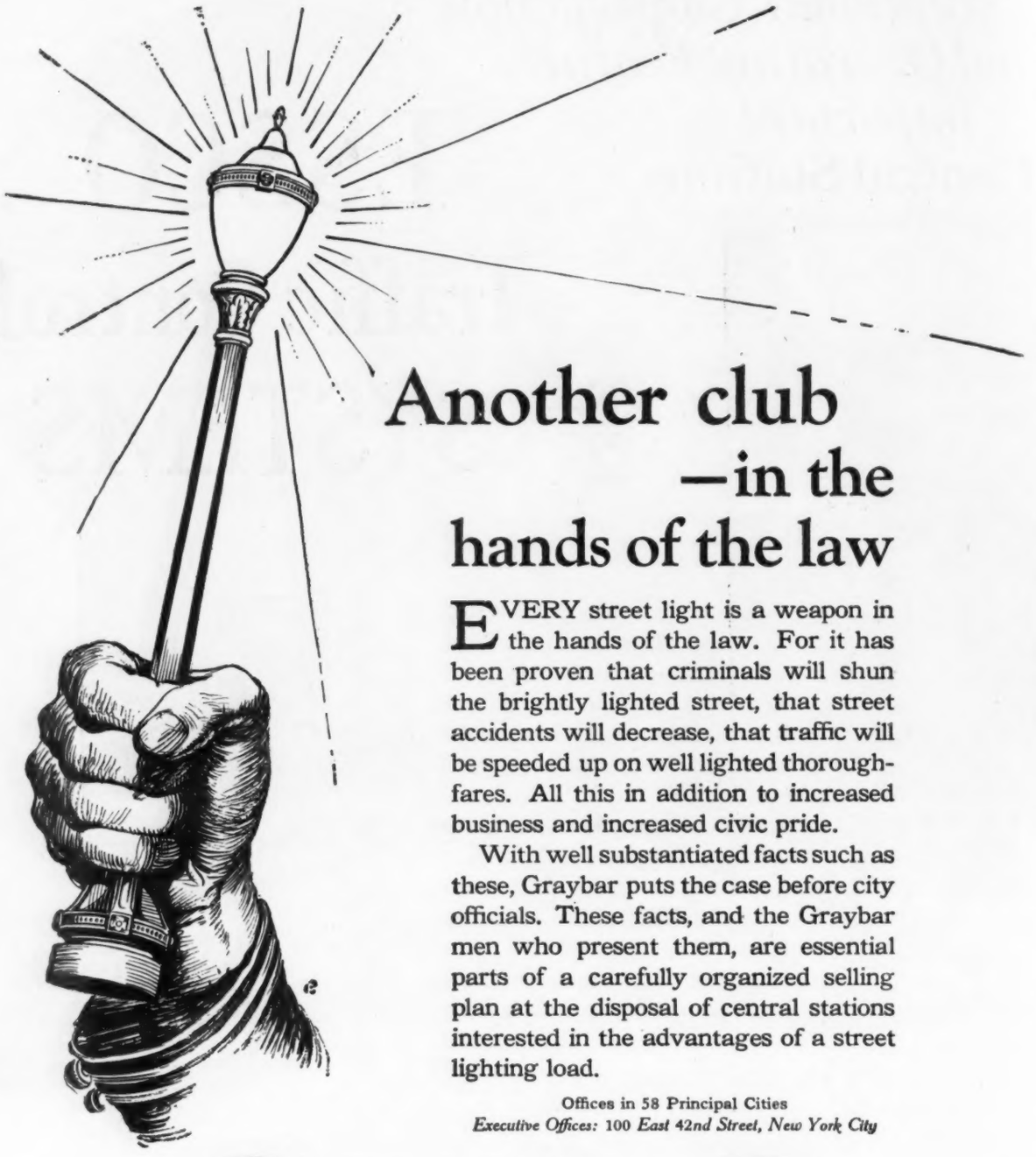
Withstands heaviest traffic and all weather conditions. Ruggedly constructed, yet of artistic design. Gets complete approval of city officials.

We render a specialized engineering service to Central Stations. Let us co-operate with you. Complete traffic data sent on request.

ESSCO MANUFACTURING CO.

111 W. Harrison St., Peoria, Ill.

PIONEER BUILDERS OF GUARANTEED TRAFFIC EQUIPMENT



Another club —in the hands of the law

EVERY street light is a weapon in the hands of the law. For it has been proven that criminals will shun the brightly lighted street, that street accidents will decrease, that traffic will be speeded up on well lighted thoroughfares. All this in addition to increased business and increased civic pride.

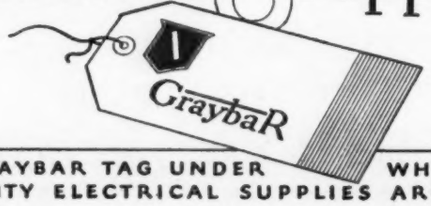
With well substantiated facts such as these, Graybar puts the case before city officials. These facts, and the Graybar men who present them, are essential parts of a carefully organized selling plan at the disposal of central stations interested in the advantages of a street lighting load.

Offices in 58 Principal Cities
Executive Offices: 100 East 42nd Street, New York City

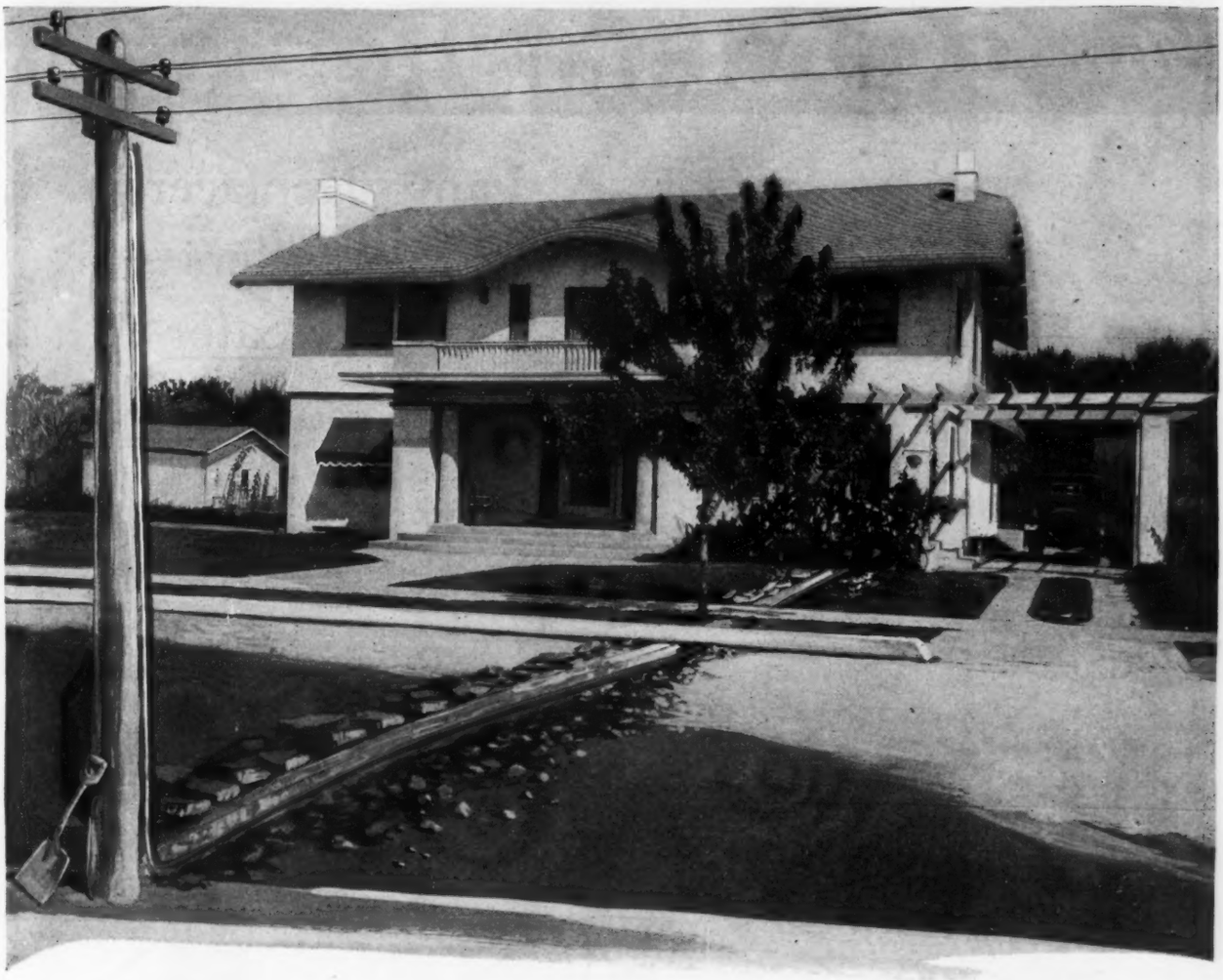
GraybaR

Successor to Western Electric Supply Dept.

Electrical Supplies



THE GRAYBAR TAG UNDER WHICH 60,000
QUALITY ELECTRICAL SUPPLIES ARE SHIPPED



CONDEX—from pole to meter
—the ideal underground service cable

Condex Underground Service Cable is new! It is constructed exactly as Condex Park Cable and can be laid underground without danger of grounds or short circuits.

No metal or other conduit is required, and it does away with the unsightly wires which are so objectionable to home owners.

Condex Underground Service Cable consists of two insulated conductors, lead covered, and protected by an interlocking steel tape, under and over which is a bedding saturated with a preservative compound.

The Flexible, locked steel conduit is a steel tape applied spirally around the lead-covered conductors. This steel armor and the unique way in which it is applied form the main distinguishing feature of Condex Underground Service Cable. Full details and quotations upon request.

SIMPLEX WIRE & CABLE Co

MANUFACTURERS

201 DEVONSHIRE ST. BOSTON

New York Chicago San Francisco Cleveland Saint Augustine

Simplex Wire & Cable Co.,
201 Devonshire St., Boston, Mass.

Gentlemen:—

Please send quotations on Condex Underground Service Cable.

Name .....

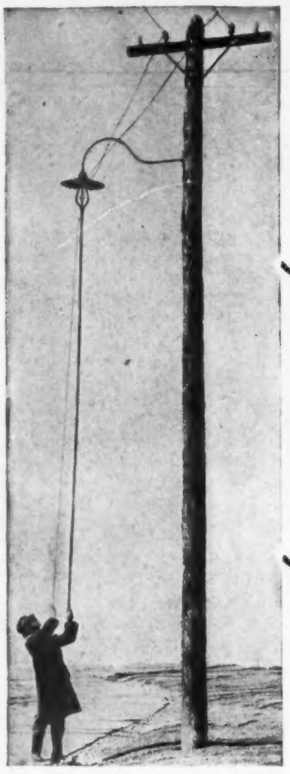
Position .....

Company .....

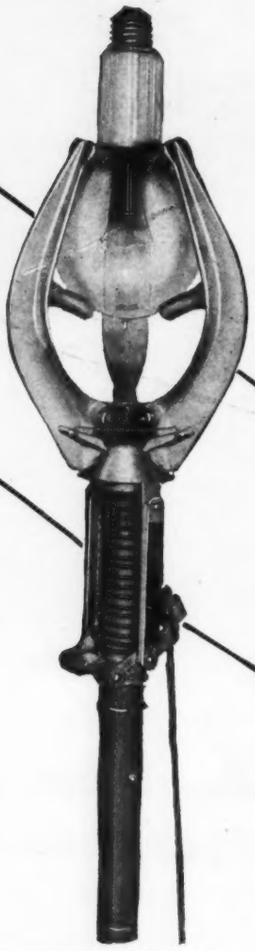
Address .....

City ..... State .....

The G.C.A. Lamp Replacer



G. C. A. Lamp Replacers and Fuse Plug Pullers— are Safer and Faster



Model D Replacer
For Multiple Lamps

Model FP-1
Fuse Plug Puller

Saving 75% of Time

Also made for series lamps and for lamp bases

The lamp-man walks his route with a basket of lamps. Each time he discovers a burned out lamp he—gets a ladder? Certainly not! He simply applies the sure and safe G.C.A. method and has a new lamp in, in a jiffy, without climbing a ladder or the pole. But suppose he must contend with a broken bulb and an imbedded lamp base. That too, is simple. He attaches the Lamp Base Remover to the same pole, jabs the base lightly, and *unscrews it.*

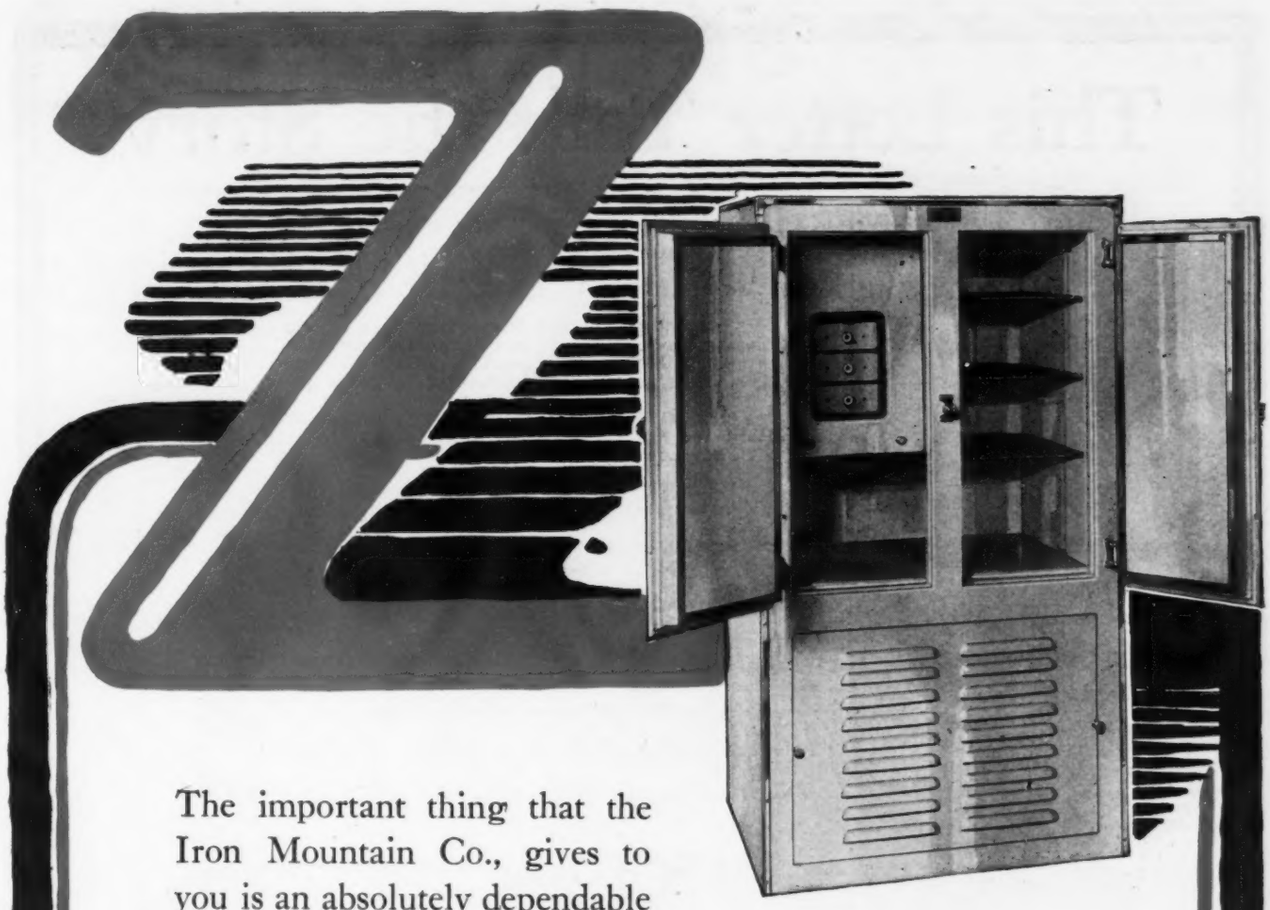
Easy enough, isn't it?

Fuses behave the same way.

The positive, simple action and the immensely superior performance of G.C.A. lighting accessories have given them exclusive places in the country's foremost utilities, where they lower accident and wasted time figures.

Our bulletin tells you more. Write

The G.C.A Manufacturing Co., Pittsfield, Mass.



The important thing that the Iron Mountain Co., gives to you is an absolutely dependable product. ZEROZONE refrigerators are built to fully meet both the customer's requirements and that of the CENTRAL STATION.

A proven successful refrigerating line—a large well equipped factory—financial strength and a complete sales plan forms the basis for a most active selling campaign.

IRON MOUNTAIN CO.

929 E. 95th Street
CHICAGO, ILLINOIS

Zerozone

Colder-than-Ice Refrigeration

This Letter Tells the Story

Franklin Ice Cream Co.,
Lincoln, Nebraska.

Gentlemen:-

On our recent inspection trip of our inspector at your plant, our inspector advised that you no longer are operating your Model "D" Walker truck serial #189 purchased in 1912.

Will you kindly advise the writer what disposition has been made of this truck. Thanking you in advance for this information.

Very truly yours,

Jas F Stumbaugh

FWB:EM General Service Manager

Your inspector is mistaken. This truck was in the paint shop. We expect to use this truck for 15 or 20 years longer.

Franklin Ice Cream Co.

Ready for Another 14 Years of Service

For truck quality that is still earning profits for you after first cost has been entirely depreciated off your books, build your city fleet of Walker Electrics, in which every unit from bumper to tail light is time tested. Write today for new folder—"What They Say, not What We Say."

Walker Electric Trucks offer Central Stations two profits—on their own deliveries, and on sales of current for charging trucks.

WALKER VEHICLE COMPANY
CHICAGO

WALKER ELECTRIC TRUCKS

LOWEST TRUCKING COST ON CITY ROUTES

NATIONAL ACCEPTANCE

by Electrical Contractors, Dealers, and Jobbers has shown for years they appreciate the efforts of The Paulding Engineering Department which has spent thousands of dollars developing WIRING DEVICES OF MERIT, rendering invaluable service to the entire electrical industry.

The Paulding Co. has always BEEN FIRST to give the electrical industry everything new and practical in wiring devices at MODERATE PRICES.

For instance, years ago, our Engineering Department developed this socket embodying

The Paulding Socket is interchangeable. The shells fit other makes of bases and our bases fit other shells. Made in key and keyless types.

QUALITY FIRST, not just something to sell, but built to install easily, and to LAST.

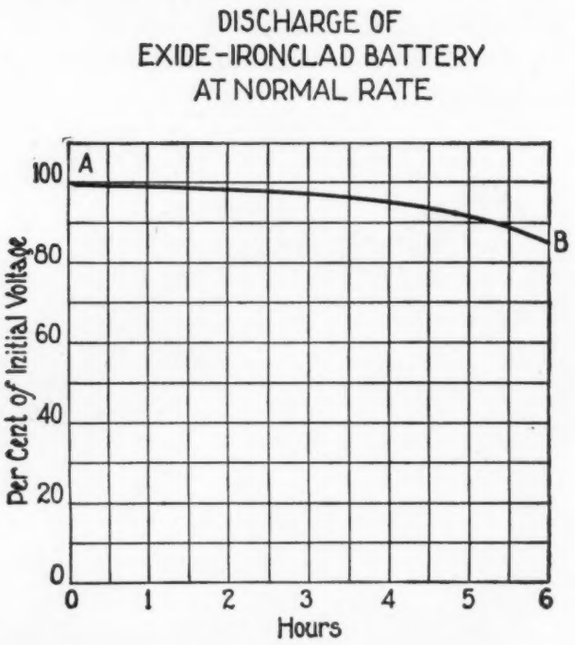
This PAULDING SERVICE gained the confidence of electrical contractors, dealers and jobbers. They appreciated the merits of this socket and for months our factory has been taxed to capacity to supply the demand.

Electrical Contractors want these sockets, and jobbers are pleased to supply them. Architects and Engineers specify and demand them.
Tests show they are QUALITY at a moderate price.

John I. Paulding, Inc.

New Bedford, Mass.

The high final voltage of this battery gives high final speed to your trucks



This chart shows how the voltage of the Exide-Ironclad remains high throughout the discharge

THE speed of an electric truck, of course, depends upon the voltage of its battery. And because the voltage of an Exide-Ironclad Battery remains high clear to the end of the discharge period, this battery drives an electric truck at a fast speed all day long.

As an Exide-Ironclad is discharging, its voltage tapers off gradually, as you will see in the accompanying chart. With an initial voltage for each cell of 2.06, at normal discharge rates the average voltage for the Exide-Ironclad is 1.98, and the final voltage 1.75—still enough to hustle the truck back to the garage.

The high final voltage of the Exide-Ironclad is only one among many good points that it has. For instance, there is its high-power ability. This battery has the ability to deliver an increasing power output up to 28 times the normal rate of discharge.

Its construction is so rugged that it gives years of trouble-free service. The unique construction of the positive plates—with the active material contained in slotted hard-rubber tubes—greatly increases the useful life of the battery. The negative plates are unusually thick, to meet the increased life of the positive plates. The Exide Giant Compound jars are practically unbreakable in normal service.

More than fifty per cent of all the electric street trucks in central station service are powered by Exide-Ironclad Batteries.

It is a significant fact that of all the electric trucks operated by central stations, *more than* half are equipped with Exide-Ironclad Batteries. And not only is the Exide-Ironclad the battery choice of electrical engineers everywhere, but it is also used by hundreds of the industrial leaders of this country.

You will find full information about the Exide-Ironclad in our booklet, "Facts for consideration in Selecting a Battery," Form No. 2865. Send for a copy today—it is interesting reading.

Member SERVICE THE SOCIETY FOR ELECTRICAL DEVELOPMENT SAFETY
Move It Electrically

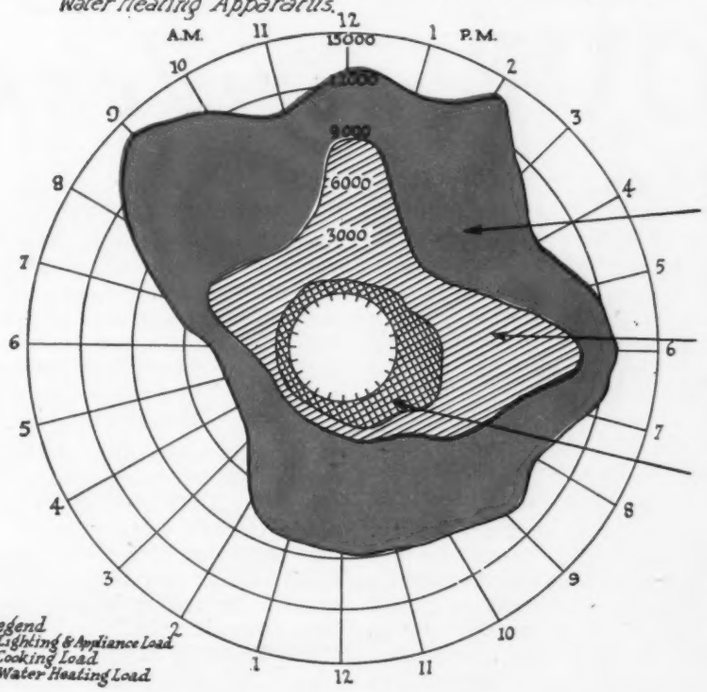
Exide IRONCLAD BATTERIES

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia

Exide Batteries of Canada, Limited, 153 Dufferin Street, Toronto

Do you know what Sepco Water Heating will do for you— your customer— and your Merchandise Dep't?

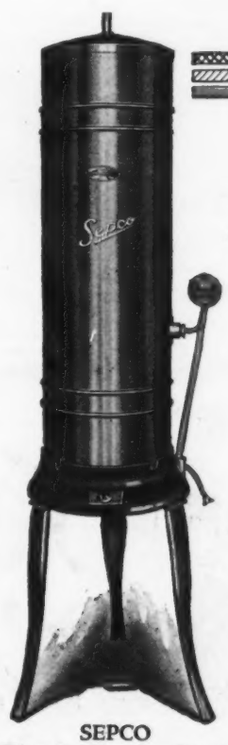
Analysis Showing Component Parts of Load Curve of 20000 Consumers Using Electric Lighting, Cooking and Water Heating Apparatus.



With the inducement type of rate this shows the chart extended to water heating which would so improve the customers load factor in conjunction with ranges and other appliances as to earn about $160.00 per annum per kilowatt of demand or 16% on the investment to serve.

Using the rate shown below, the lighting operates at a load factor of about 8% but the low follow-on rate encourages the use of appliances, refrigerators and ranges which would raise the load factor to about 25.3% and would yield an annual revenue of $110.00 per kilowatt.

20% of the residential customers in the country who pay the following rate; 5 cts. for first 60 hours' use of demand. Billing demand 50% of connected load. Minimum billing demand 1½ kilowatts. 6 cts. for 2nd 60 hours' use of demand. 5 cts. for excess, shows that the average load factor is about 11% and the yield is but $78.00 per annum which is below the cost to serve.



SEPCO
"Electric Thermos Bottle"
Keeps Water Hot
at Lowest Cost

Your Rate Schedule is the Answer!

Below we suggest an inducement type of rate that will encourage larger residential consumption and will so improve the customers load factor as to bring in a return of about $160.00 per annum per KW. of connected load, or a return of 16% on the investment dedicated to serve this class of business.

8 cts. for 1st 60 hours use of demand. (Billing demand; 25% of connected lighting load; 2.5% of any range, water heater, or other appliance of 1 kilowatt or over).

3½ cts. for next 120 hours use of demand.

2 cents for all excess

This rate will so improve consumer load factor that it will result in an annual revenue of $160 per KW. or 16% on investment dedicated to serve.

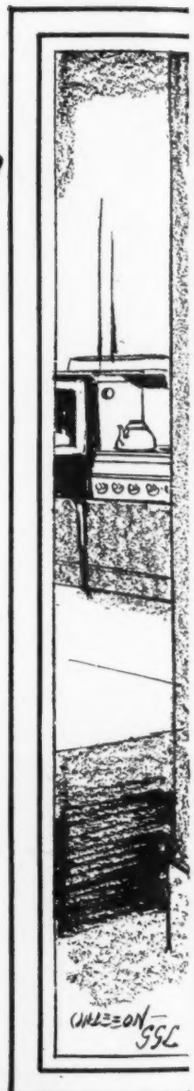
Let Sepco help you to accomplish this most desirable end. Our trained field engineers have experience that you can use—why not ask us for it.

Automatic Electric Heater Co.

1505 Race Street, Philadelphia, Pa.
Factories: Pottstown, Pa. Toronto, Canada

These are

~who will pay YOUR *dividends!*



They live in homes that are properly appliances — homes that are well equipped with electric heating and cooking devices.

They cook with an electric range; electricity also brews their coffee, and toasts their bread; with an electric griddle, their waffles are made. They're also favorably familiar with the cheery glow of a radiant heater. And their laundry is modern with an electric ironer.

And yet, theirs is not a home of luxury. It is rather a home of convenience and economy, where every cent of their income-dollar is put to good use. And they do not think that their power bills are high; for they have learned that there is no dollar that buys as much as does the dollar they spend for electricity.

And theirs are the dollars that pay your dividends. They add to your income without increasing your investment. But they are all too few in number. Only seven in one hundred homes are rightly appliances. They present to you a market for power that you can't afford to over-look.

It is noteworthy, that the bulk of this market was created, and is now sustained by CHROMEL, the wire that made electric heat possible. And if you were familiar with the story of CHROMEL, you'd have a better background for selling heating appliances. The story is told in a booklet called "The Friendly Enemy," and we'll be pleased to send you a copy.

HOSKINS MANUFACTURING COMPANY
4433 Lawton Avenue, DETROIT, MICHIGAN

New York
Grand Central Terminal

Chicago
Otis Building

Cleveland
Leader-News Building

Boston
Park Square Building

CANADIAN REPRESENTATIVES:
Hiram Walker & Sons Metal Products, Limited, Walkerville, Ontario

San Francisco
1151 *Market Street*

Chromel

MEANS ELECTRIC HEAT

◇ ◇ ◇ **Hoskins**

THE WIRE THAT MADE

the People

Chromel ◇◇◇

ELECTRIC HEAT POSSIBLE

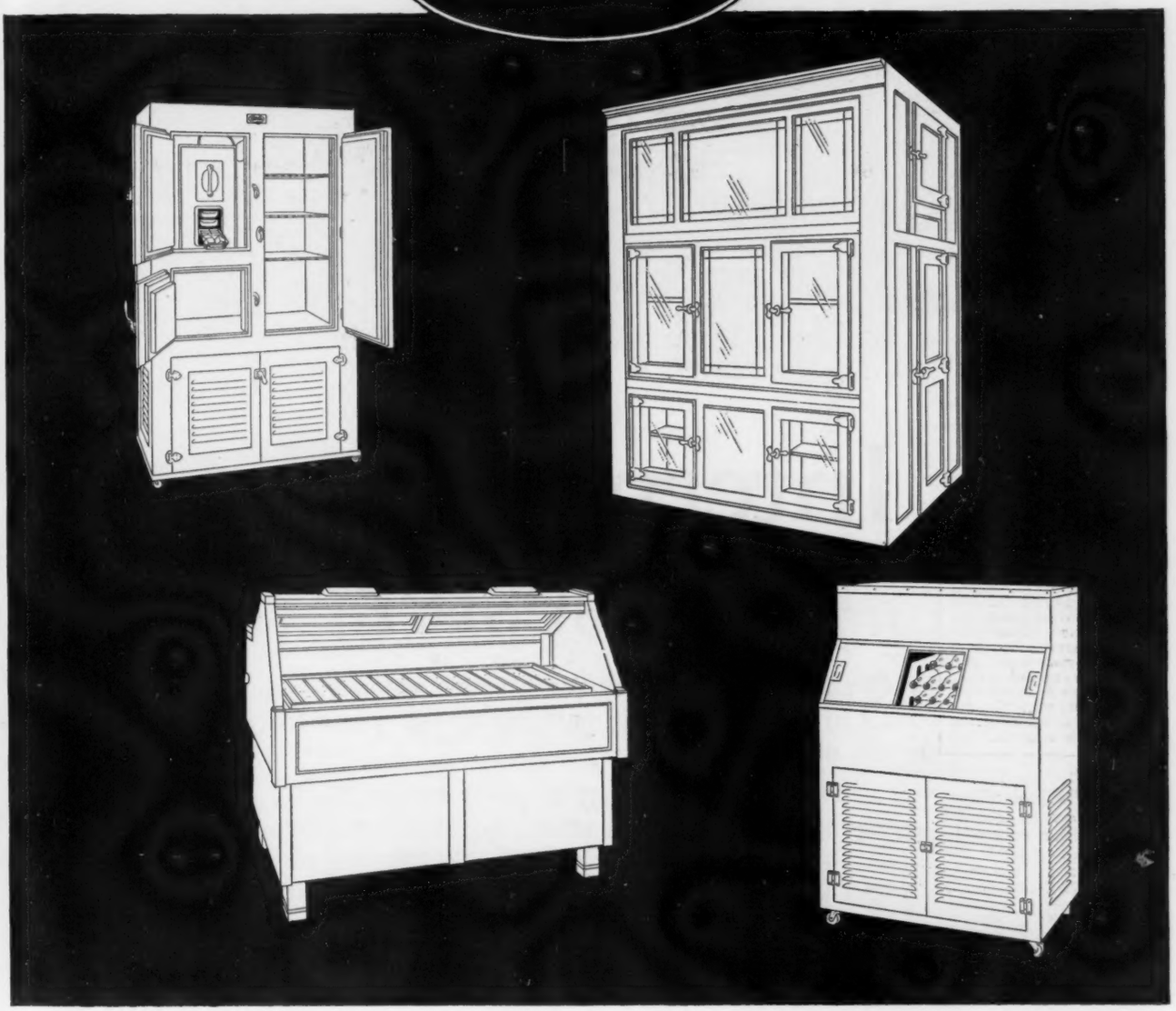
AUTOMATIC SERVEL REFRIGERATION

Sell more electricity to stores

At least one-half the stores in your community sell food. Every food store is a logical prospect for Servel refrigeration. Servel carries the logic a little further—and provides refrigerating units that meet the business requirements of these stores.

Many smaller stores find sufficient refrigerating space in one of the seven domestic Servel models. Others require specialized equipment—and the Servel line includes for them such items as dry-cold bottled-beverage cabinets; meat and delicatessen display cabinets; and big refrigerators for commercial use.

AUTOMATIC SERVEL REFRIGERATION



Storekeepers, accustomed to large ice bills, welcome the cheaper and far superior service given by Servel refrigeration. Their consumption of electricity for refrigeration is much heavier than is required for home use. The Servel commercial line is constantly under development in co-operation with men and companies who have made long studies of the refrigeration needs of businesses.

6131-23

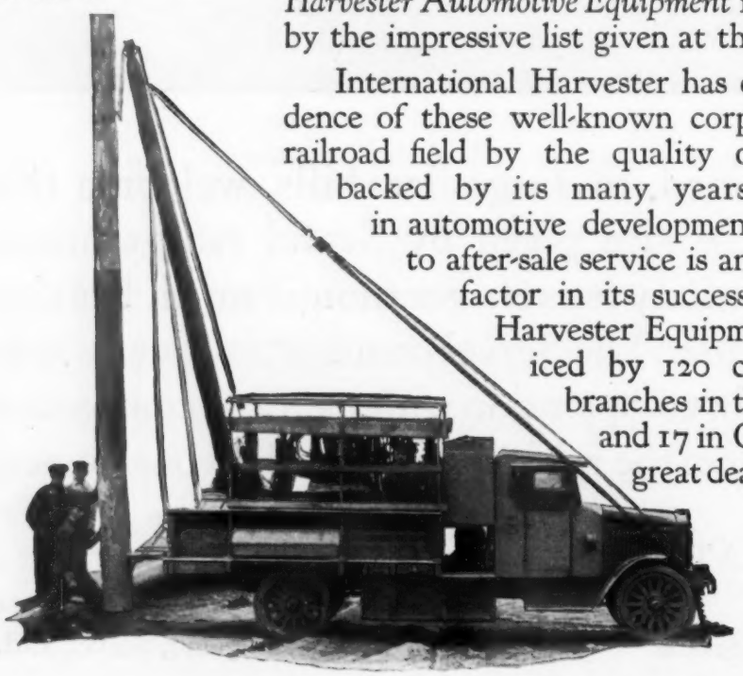
THE SERVEL CORPORATION, 51 East 42nd Street, New York

Chicago Boston Detroit Minneapolis Salt Lake City Atlanta
San Francisco Los Angeles Seattle Dallas London, England, Servel, Ltd.

ABOVE: *Two items of the equipment of the Canadian National Electric Railways —International 3-ton truck, and a new electric locomotive.*

THE Canadian National Electric Railways operate a 1500-volt line running from Toronto to Georgetown, Acton and Guelph, running frequent high-speed electric passenger trains. Fast freight twice a day and same day delivery service is maintained all year around. For less than carload freight shipments a fleet of trucks co-ordinates with the rail movements, rendering fast merchandise dispatch.

BELOW: *Hundreds of Internationals are in telegraph and telephone construction and maintenance work. This one serves the Columbus, Delaware & Marion Electric Co. (Ohio)*



International Harvester

STEAM and electricity and gasoline are working in an interlocking partnership—a powerful trio of power.

The flexible efficiency of good motor trucks, coaches and industrial tractors nowadays plays an amazing part in steam and electric railroad operation. The preference for *International Harvester Automotive Equipment* is forcibly shown by the impressive list given at the right.

International Harvester has earned the confidence of these well-known corporations in the railroad field by the quality of its products, backed by its many years of experience in automotive development. Its devotion to after-sale service is another important factor in its success. International Harvester Equipment is now serviced by 120 company-owned branches in the United States and 17 in Canada and by a great dealer organization.

Some of the Railroad, Express and Allied Companies Owning International Harvester Automotive Equipment

American Railway Express
Atchison, Topeka & Santa Fe
Baltimore & Ohio
Boston Elevated
Canadian National Express
Canadian National Railway
Canadian Pacific
Chicago & North Western
Chicago, Burlington & Quincy
Chicago Junction Railway
Chicago, Milwaukee & St. Paul
Chicago, Rock Island & Pacific
Dominion Express
East Mass. Street Railway
Elgin, Joliet & Eastern
Gary Railways
Great Northern
Illinois Central
Illinois Traction Company
Indiana Service Corporation
Interstate Public Service Company
McCormick Steamship Company
Milwaukee Electric Railway
Minneapolis & St. Louis
Missouri, Kansas & Texas
Missouri Pacific
Monon Route
New York Central Lines
New York, New Haven & Hartford
Nickel Plate Road
Norfolk & Western
Northern Ohio Traction Lines
Northern Pacific
Norton Lilly Steamship Company
Pennsylvania System
Pittsburgh & Lake Erie
Pullman Company
St. Louis, Southwestern
Soo Line
Southeastern Express
Southern Pacific
Southern Railway
Texas & Pacific
Union Pacific

Please mail inquiries to the Chicago address

INTERNATIONAL HARVESTER COMPANY
606 So. Michigan Ave. *of America (Incorporated)* Chicago, Ill.

WONDERPHONE DISPATCHERS' SWINGING ARM SET

THE OUTPUT of the ordinary transmitter is limited by amount of current it can carry before being paralyzed by heating, and permanently injured. The "Wonderphone" transmitter carries approximately 10 times that of ordinary transmitter, where necessary, and can be operated successfully on from 3/10 to 3 amperes of current. Allowance for effects of heating is made by using specially constructed carbon cell.

Construction of the Wonderphone transmitter is shown in illustration below. Differential type of construction is used, employing two carbon cups, one front and one behind diaphragm, larger than ordinarily used.

Another and very important feature of transmitter is that *it absolutely will not pack. One never has to "shake up" a Wonderphone.*

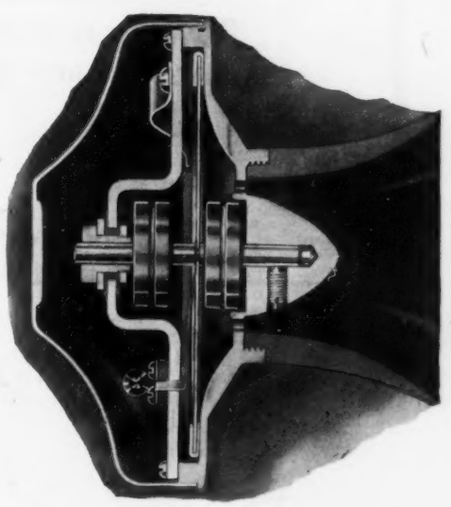
There is ONLY ONE telephone made *expressly* to improve communication between power stations!

Among the Hundreds of Users of Wonderphones are:

Minnesota Power & Light Company, *Duluth, Minn.;* Monongahela West Penn Public Service Co., *Fairmont, W. Va.;* Northern States Power Company, *Eau Claire, Wis.;* The Porto Rico Railway Light & Power Co., *New York, N. Y.;* Pennsylvania Edison Company, *Easton, Pa.;* South Georgia Power Company, *Albany, Ga.;* San Joaquin Light & Power Corporation, *San Francisco, Cal.;* South Carolina Gas & Electric Company, *Spartanburg, S. C.;* The Tennessee Electric Power Company, *Chattanooga, Tenn.;* Truckee River Power Company, *Reno, Nevada;* Utah Power & Light Company, *Salt Lake City, Utah;* United States Stores Co., *Nome, Alaska;* West Texas Utilities Company, *Abilene, Texas.*

Columbus Electric & Power Company, *Columbus, Ga.;* Eastern Oregon Light & Power Company, *Baker, Oregon;* Pacific Gas & Electric Company, *San Francisco, Cal.;* Northwestern Electric Co., *Portland, Ore.;* Phoenix Utility Company, *Salt Lake City, Utah;* Puget Sound Power & Light Company, *Tacoma, Wash.;* Pacific Power & Light Company, *Portland, Ore.;* Southern Colorado Power Company, *Pueblo, Colo.;* Idaho Power Company, *Boise, Ida.;* Adirondack Power & Light Corporation, *Schenectady, N. Y.*

Central Illinois Public Service Co., *Springfield, Ill.;* Copper River & Northwestern Rly. Co., *Cordova, Alaska;* Central Hudson Gas & Electric Co., *Poughkeepsie, N. Y.;* Georgia Railway & Power Company, *Atlanta.*



Wonderphone

10 times the volume *gets the message thru*

UNIVERSAL HIGH POWER TELEPHONE CO.
Carleton Ave. and Eddy Street, Seattle.

Gentlemen: Please tell us how the Wonderphone can be used by us to improve our communication system.

*Firm*_____

*Address*_____

*Your Name and Title*_____

The greatest factor in CENTRAL STAT

for

DOMESTIC LOAD BUILDING
the biggest thing on the skyline
is the ELECTRIC RANGE

In building to provide for the future of the Domestic load read the survey prepared by the N.E.L.A.—The Range Report—submitted to the Convention this year. The data on load factor and diversity factor of the range shed new light on this profitable business.

DRIVER-HAR

Harrison, N. J.
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ION BUILDING *is Load Factor*

—and for

INDUSTRIAL LOAD BUILDING—
the electric furnace and oven will eclipse its predecessor—the motor

No well-founded program of central station construction can ignore the tremendous demand, already evident, for electric heat. The best information available points to a future heating load, larger than the present motor load.

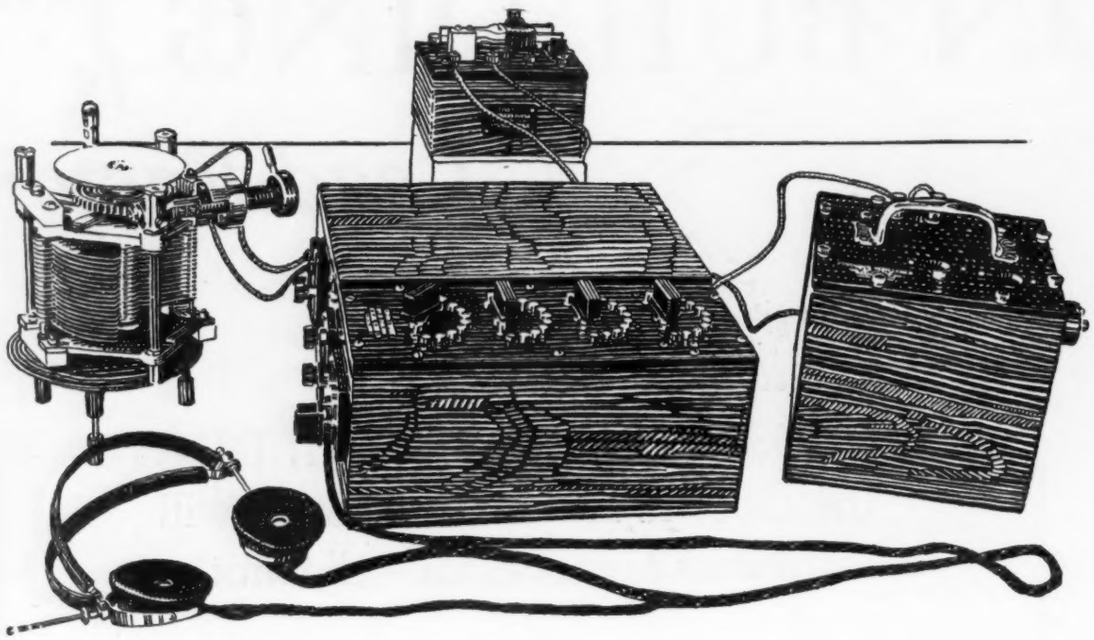
Nichrome IV
High Temperature Service

RIS COMPANY

Morristown, N. J.

England France

PRECISION IN RADIO



The science of radio has reached its present day development only by careful study of fundamental principles. In this study laboratory instruments capable of making extremely accurate measurements have been necessary.

For nearly a decade the General Radio Company has been manufacturing radio laboratory instruments and parts—the outstanding feature of which is PRECISION.

These instruments have been supplied in ever increasing quantities to many well known radio laboratories of the country, including the leading engineering colleges.

Why not let us serve you in your needs for laboratory equipment and apparatus for your home radio receiver?

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Consider the quality and you will choose **PARANITE**

The choice of the right wire for all wiring is highly important. You must be sure of the quality. **PARANITE** has those vital features that help make the finished job greatly appreciated. Your men can do better jobs with wire easier to handle. **PARANITE** wires and cables have been consistently "better than code requires," and all that the job requires. **PARANITE** is durable—and no more costly than other "code wires."

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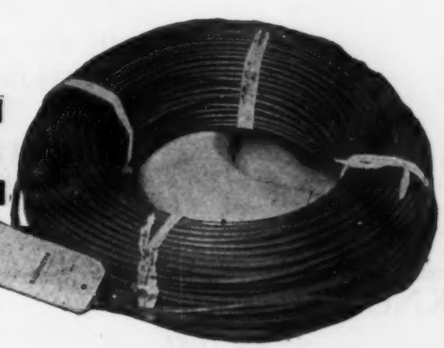
If it's

PARANITE

it's right



In Power Station Construction

* Turbo-Generators
* Switchboards
* Insulators
§ Fuel
§ Feed Water

In Substation Construction

* Transformers
* Batteries
* Oil Switches
*† Insulators
† Connectors
* Regulators
* Lightning Arrestors
* Relays
* Wire
* Converters
* Switchboards

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—the important item in Central Station Construction

In organic chemistry the names of complex substances are built up by using in whole or part the names of the various constituents.

Therefore it is logical that ELTESTLAB be used to differentiate ordinary laboratory tests from those made in the light of the widespread experience and unusual facilities afforded by

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* For the benefit of E.T.L. clients in every land ELTESTLAB is the registered code word for E.T.L.

KNOW
—by test

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* Wire
* Fuses
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† Connectors
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* Choke Coils
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* Wires
† Guy Wire
* Lightning Arrestors
† Anchors
* Ground Wire
* Switches

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Reports, Appraisals, Designs,
Construction and Operation
507 Tramway Building Denver, Colo.

"*His* name is familiar"

Natural interest in "Who's Who" among Consulting Engineers in the electrical industry fosters the attention of readers to the cards printed here week after week.

The value of this publicity is evidenced when a reader becomes a prospective client—through the card or otherwise—and confidence in his selection is in large measure based on the fact that "*His* name is familiar"—because it has become so through this advertising.

Clip and mail the coupon for further information.

Professional Directory Department
ELECTRICAL WORLD
10th Ave. at 36th St., New York

Gentlemen:

Please send us rates and other data for advertising in your PROFESSIONAL DIRECTORY.

SEARCHLIGHT SECTION

USED MACHINERY & NEW—BUSINESS OPPORTUNITIES

UNDISPLAYED—RATE PER WORD:

Positions Wanted, 4 cents a word, minimum 75 cents an insertion, payable in advance.

Positions Vacant and all other classifications, 8 cents a word, minimum charge $2.00.

Proposals, 40 cents a line an insertion.

INFORMATION:

Box Numbers in care of any of our offices count 10 words additional in undisplayed ads.

Discount of 10% if one payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

DISPLAYED—RATE PER INCH:

1 to 3 inches.....$5.00 an inch
4 to 7 inches..... 4.80 an inch
8 to 15 inches..... 4.60 an inch

An advertising inch is measured vertically on one column, 3 columns—30 inches—to a page.

E.W.

He Got A $50.00 Salary Increase

"I was able to secure my present position after having completed your course, at an increase in salary of $50 per month. I secured this position so soon after completing my studies that I had not received my diploma. I find the things I learned from the course are of benefit to me every day. Any ambitious man will surely be able to double his salary in a short time after completing his studies."

YOU MAY DO AS WELL OR BETTER

There is a constant demand for trained men in every walk of life. There is NOW a particularly great demand for Meter Experts by Central Stations everywhere. During the coming year 2,000,000 new meters will be installed. This calls not only for a vast army of testers and installation men, but for those with expert knowledge of this work to direct others.

WE TRAIN YOU

Within a few months' time we will train you to become a Meter Expert. No need for you to give up your present job and attend school. You learn in your spare time right at home—while you are earning.

BE A METER EXPERT

If you are ambitious to better your job and increase your salary, here is an opportunity to do so. The work is fascinating and there are good jobs awaiting capable men. Our students make rapid progress. We have many letters telling of quick promotions and higher salaries won as a result of studying our course.

MAIL THE COUPON FOR FREE BOOK

We will send you without obligation on your part, our FREE BOOK telling you all about your opportunities as a Meter Expert and how you can study to become one at home in a very short time. You owe it to yourself to find this out.

Ft. Wayne Correspondence School
Dept. 48, Ft. Wayne, Ind.

FREE—Book Coupon

Ft. Wayne Correspondence School
Dept. 48, Ft. Wayne, Ind.

Gentlemen: Please send absolutely free and prepaid your book on Meter Engineering. Also send me full particulars of the great special offer that is now being made to induce men to study Meter Engineering. I assume no obligations of any sort.

Name .....

Address .....

POSITIONS VACANT

CHIEF operating engineer between 30 and 40 years of age capable of maintaining and operating 50,000 kw. turbo-generator station, technical training preferred. Splendid opportunity. In writing give complete experience, education and photograph. P-432, Electrical World, Tenth Ave. at 36th Street, New York.

ELECTRICAL design engineer. A position is open for a designer of large direct current machines having at least five years' design experience; experience in steel mill applications of direct current motors is desirable. Apply to Power Engineering Department, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Give full particulars concerning age, technical education, design experience, references, salary expected and date when available.

ENGINEERS to pursue management training course with large public utility company in Central and Eastern New York State. Applicants for positions should be college graduates. P-439, Electrical World, Tenth Ave. at 36th St., New York.

EXCELLENT opportunity for a first-class young electrical engineer for development work in large manufacturing industry. Must be a college graduate with two or three years' experience in testing a.c. and d.c. motors and control apparatus. Good salary to man meeting our requirements. Apply in writing to P-423, Electrical World, Tenth Ave. at 36th St., New York, giving age, training and experience.

WANTED—A man to act as working foreman for station construction and maintenance work. Also man for testing overload relays and general testing for utilities company in northern Illinois. State age, experience, education, and minimum salary. P-442, Electrical World, 7 So. Dearborn St., Chicago, Ill.

WANTED

Commercial and Operating Manager

for

Electric Utility

in Southeastern city of 25,000 people

Must be a tactful mixer, capable of developing and maintaining favorable public relations. Necessary to have sufficient engineering and operating experience to get best results from steam-turbo plant, transmission and distribution systems.

Give age, complete experience and training, family responsibilities, salary expected, when available, and supply recent photograph.

An energetic, resourceful worker will find here an exceptional opportunity for advancement.

P-427, Electrical World
1600 Arch St., Philadelphia, Pa.

"Approved"

Week after week the electrical industry writes across these pages—in the form of advertisements published—its approval of "Searchlight" Service. *And no wonder*—

The electrical man, at every stage of his career, finds advertising in the Searchlight Section of *Electrical World* a handy tool for shaping up his plans.

As a young college graduate he may secure his first employment through his own advertisement or through those of positions open. Later, by similar advertising he may secure positions of greater responsibility or more varied experience.

Eventually, as an executive, or in his own business, he may use "Searchlight" advertising to secure the skilled men he needs, to interest capital in his enterprise, to build up a selling organization, to find additional products to manufacture, to secure equipment or dispose of it, and so on, even to the point—when he is ready to retire—of selling his business or interest.

The Searchlight Section of *Electrical World* tells electrical men throughout the industry of positions vacant and wanted for skilled and professional men on operating and executive staffs, and for trained men for office and sales work, tells them also of investment, sales and purchase opportunities.

The thousands upon thousands of replies addressed to "Searchlight" advertisers measures the interest of *Electrical World's* readers in the Searchlight Section.

Advertisers' acknowledgements testify to the Searchlight Section's invaluable service in finding the right men for situations and situations for the right men, and in filling business needs that range from the sale of new inventions and patents to the disposal and purchase of going businesses.

Any service that really serves is bound to succeed. Extensive use, week after week, is the electrical industry's endorsement of *Electrical World's* "Searchlight" Service.

POSITIONS VACANT

FIRST-CLASS motor repair men wanted. Must be familiar with general motor repairs, rewinding, etc. Write H. E. Lowe Electric Co., Macon, Georgia.

LINEMEN wanted by large lighting company operating suburb of New York City; steady position and standard wages to right men; safe working conditions; no labor troubles. P-335, Electrical World, Tenth Ave. at 36th St., New York.

LINEMEN wanted for light construction work, small town North Central Illinois. P-436, Electrical World, 7 So. Dearborn Street, Chicago, Ill.

1924-5 electrical engineering graduates to be trained for sales positions; several openings exist for men of exceptional ability. The Electric Controller & Manufacturing Co., 2700 E. 79th St., Cleveland, Ohio.

ILLUMINATING engineer, capable supervising design and production of floodlighting units, searchlights and other illuminating equipment. Also with ability to make layouts and installation recommendations on special floodlighting work. Headquarters Philadelphia. State age, education, experience, salary desired, full details in first letter. P-418, Electrical World, 1600 Arch St., Philadelphia, Pa.

EMPLOYMENT SERVICE

IF YOU are qualified for position between $2,500 and $25,000, and are receptive to negotiations for new connection, your response to this announcement is invited. The undersigned provides a thoroughly organized service, established sixteen years ago, to conduct confidential preliminaries, and assist the qualified man in locating the particular position he desires. Not an employment agency. Retaining fee protected by refund provision, as stipulated in our agreement. Send name and address only for description of service. R. W. Bixby, Inc., 262 Main Street, Buffalo, N. Y.

EXECUTIVES, engineers, find our individual, confidential service effective in making new connections. Personally planned by Jacob Penn, the eminent employment authority, known to leading business men throughout America. Refund agreement protects you. Not agency. Jacob Penn, Incorporated, 305 Broadway, New York.

POSITIONS WANTED

AS general foreman or assistant superintendent on high tension line work, tower or pole, 18 years' experience. PW-415, Electrical World, Tenth Ave. at 36th St., New York.

ASSISTANT to general manager or superintendent; electrical engineer. Construction, operation, maintenance steam power plants. Minor executive experience. Knows Spanish. PW-362, Electrical World, Tenth Ave. at 36th St., New York.

AS assistant superintendent or general foreman, substation or line work. Technical graduate. Now employed as general foreman by large power company. PW-429, Electrical World, Tenth Ave. at 36th Street, New York.

AS assistant superintendent or general foreman, 20 years' experience in construction of transmission and distribution lines. American; speak Spanish; go anywhere; available now. PW-431, Electrical World, 1600 Arch St., Philadelphia, Pa.

COMMERCIAL department manager desires connection, has handled power and lighting sales, merchandising, rate studies, public relations and advertising, some operating experience. Age 31. PW-419, Electrical World, 1600 Arch St., Philadelphia, Pa.

GRADUATE electrical engineer experienced in executive work; test and repair of meters, batteries, small motors, and automotive equipment; wants position, anywhere. Age 39. Single. PW-424 Electrical World, 7 So. Dearborn St., Chicago, Ill.

TECHNICAL SERVICE
217 Broadway, New York, N. Y.

Specialists in
TECHNICAL PERSONNEL

POSITIONS WANTED

CIVIL engineer, 29, six years' responsible charge power plant and transmission line construction and engineering, seeks public utility connection, with ultimate aim of property management. PW-401, Electrical World, 1600 Arch St., Phila., Pa.

GRADUATE electrical engineer; 12 years construction, operation, maintenance steam power plants. Installation, meters. Speaks Spanish. Go anywhere. Minimum $3,600. PW-361, Electrical World, Tenth Ave. at 36th St., New York.

GRADUATE electrical engineer, age 36, single, executive ability available for responsible position with public utility, 15 years' varied technical and commercial experience with large gas and electric companies on general engineering, power sales, statistics, operation and construction. PW-422 Electrical World, 7 South Dearborn St., Chicago, Ill.

I am your man, American, single, age forty-two, twenty years on d.c. and a.c. winding, single phase, split phase and repulsion induction and polyphase, armatures, commutators, production and repair work. Twelve years as foreman; want this kind of position. Efficient, reliable, know how to get results. Best references. Will go anywhere, 60 days trial. W. H. Johnson, Box 809, Troy, N. Y.

EXPERIENCED tester, with technical education, desires a change of employers. Capable of testing all electrical power equipment including relays, polyphase meters, demand meters and instruments. Experienced in overseeing testing, repairing and application. Capable of analyzing abnormal behavior of electrical apparatus. Has been with present employer for a long period. PW-435, Electrical World, 7 So. Dearborn Street, Chicago, Ill.

MANAGERIAL executive familiar with operating, accounting, statistical, new business, public relations, development, and construction desires connection with good operating or construction company. Know electrical, gas and railway work. Can promote harmony within and without. Age 44, married. R. E. Torrance, Eau Claire, Wis.

OPERATOR, 6 years' experience in operation of 10,000 kw. steam station, wants new connection. Three years college electrical engineering course; graduate General Electric Engineering School. Married, 2 year old son. Will go anywhere living conditions are healthful—prefer South or West. References present employers. PW-443, Electrical World, Tenth Ave. at 36th St., New York.

PUBLIC utility executive seeking new connection offers nine years' experience in construction, operation, accounting and management of isolated and holding company properties. Will guarantee results with investment. PW-441, Electrical World, Tenth Ave. at 36th St., New York.

SHIFT-ENGINEER 100,000 volts English company, experienced construction branch Germany, speaking five mean idioms, disposable for South America. Pays voyage. Box 1104, Tampico (Mexico).

YOUNG man, age 19, with technical training in electrical drafting, desires a position. PW-430, Electrical World, Tenth Ave. at 36th Street, New York.

UTILITY MANAGER
Now employed, desires a new position.

PW-384, Electrical World
1600 Arch St., Philadelphia, Pa.

SALESMEN WANTED

Junior Sales Engineer

Central Station Eastern city 500,000, as assistant on power sales and service. Desire recent E.E. graduate with about one year test course, some general selling experience, pleasing apparance and personality, a hustler willing to work and learn. Excellent opportunity for the right man. Write full details and salary expected. SW-433, Electrical World, Tenth Ave. at 36th Street, New York.

Lighting Sales Engineer (Junior)

Eastern Central Station wants live hustler of good appearance and pleasing personality, able to make commercial lighting layouts and sell ideas. Should be recent E.E. graduate with special knowledge of lighting. Selling or commercial experience of at least one year very desirable. Write full details and salary expected, to SW-434, Electrical World, Tenth Ave. at 36th Street, New York.

REPRESENTATIVES WANTED

High-Class Electrical Sales Representatives wanted by the undersigned who are manufacturers of carbon, graphite, electrographitic and metallic brushes for motors and generators, also general line of carbon specialties. Exclusive rights given to each of territories on liberal straight commission sales proposition. Specify in detail past engineering and sales experience. Application by letter. Pure Carbon Company, Wellsville, N. Y.

Agents Wanted

We have real live agency proposition for live wire agents in the Middle West, South, Western New York and Western Pennsylvania, to handle our line of carbon, carbon graphite, graphite, electrographitic and graphite metal brushes. If interested write for particulars. Electro-Nite Carbon Co., 308-10-12 No. 4th St., Philadelphia, Pa.

REPRESENTATIVES AVAILABLE

Manufacturer's Agency Wanted, New England States

By executive now employed in New York City. Applicant's acquaintanceship and experience electrical trade in this section of the country will make connection profitable. RA-438, Electrical World, Tenth Ave. at 36th Street, New York.

BUSINESS OPPORTUNITIES

Partner Wanted

A-1 competent to manage good going repair shop. Investment $4,000. Good salary. Good possibilities for the right man. Don't answer if you have not the above amount. BO-394, Electrical World, Tenth Ave. at 36th Street, New York.

PATENT ATTORNEY

Patent-Sense. Valuable book (free) for inventors seeking largest deserved profits. Write Lacey & Lacey, 768 F St., Washington, D. C. Established 1869.

EDUCATIONAL

Bliss Electrical School

Condensed course in electrical engineering. Complete in one year. For men of character, ambition and limited time. Theoretical principles and practical applications of electricity. Mathematics, steam and gas engines, mechanical drawing, extensive shop work. Construction, installation, testing. Fireproof dormitories, dining hall, laboratories, shops. Established 1893. Send for catalog. 539 Takoma Ave., Washington, D. C.

WANTED—New Electrical Specialties which can be made and Sold in Quantities—

through Electrical Supply Jobbers and Dealers, to factories, hotels, apartment houses, homes, etc. Something that is either a current consuming device itself or which would be desirable and convenient or economical for use with them. The device must be patented or patentable. The inventor or owner must send complete description—a copy of patent if any has been obtained, or a copy of patent applications—a working model of the invention—cash price of all of the rights to the invention. The Company that is the author of this advertisement has been in business nearly thirty years; has an international sales organization, and is well and favorably known to the publishers of "Electrical World." Send your replies to BO-412 "Electrical World," Star Bldg., St. Louis, Mo.

P. S. In case you have not applied for a patent on your invention, the advertiser, suggests that for your own protection, you make drawings and write out a full description of your invention together with the date that you conceived the idea. Have these papers made in duplicate and have two people who know you appear with you before a notary public, and witness the fact that to the best of their knowledge and belief the invention is yours.

Send the duplicate copy of this affidavit to the above address, and it will be transmitted to the Advertiser. If interested, you will receive a letter from them; otherwise, they will return your papers and model.

Equipment wanted ads on page 128

J. L. HEMPHILL & CO. Inc.

ELECTRICAL ENGINEERS AND EQUIPMENT

801-807 Williams St. North Bergen, N. J.

Telephones: Palisade 2600-2601

MOTOR GENERATOR SETS

300 kw. 250/500 v. 3 ph. 60 cy. 2300 v. Westinghouse synch. motor generator set.
1—200 kw., 600 rev., 125 v., G. E. gen. dir. conn. to 200 kw., 3 ph., 60 cy. 440 v. westghse. synchronous motor, complete.
1—250 kw. 250 v. G. E. Generator 3 ph. 60 cy. 2200 v. synchronous motor.
1—150 kw. 250 volt Elec. Dynamic with synhcronous motor.
1—125 kw. 250 v. Westinghouse synchronous generator motor set.
1—100 kw. 250 v. D.C 2300/440 A.C.G.E. syn. motor generator set.
100 kw. 250 v. Gen. 900 r p.m 2200 synchronous motor.
1—75 kw. 250 v. Generator 3 ph. 60 cy. 2200 v., synchro nous motor.
1—37 ½-kw., 900 rev., 110 v., D.C., on same base with 60-hp. Lincoln, 220 v., sq. cage motor.
10-20-25-40 kw. 125 v. Exciter Sets.
10-20-30 kw. Balancer Sets.
7—4½ H.P. Battery Charging Sets.

TURBINE

1—400 kw. 3600 rev. 3 ph. 60 cy. 2300 v. Allis-Chalmers Barometric Condenser.

ENGINE GENERATOR SETS

1—200 kw. 250 v. D.C. Gen. connected to Allis-Chalmers 18x36 right hand Corliss Engine.
1—150 kw. 200 rev. 125/250 v. 3 wire G. E. engine type (generator only).
1—100 kw. 125 v. 2 wire D.C. Westinghouse R.H. gen. conn. to Harrisburg std. tand. cud. 11x18x13 engine 275 r.p.m. complete.
1—75 kva. General Electric 257 r.p.m 3 ph. 60 cy., 440/2300 v., dir. conn. engine generator sets.
1—60 kva. G. E. 300 rev. 240 v. dir. conn. to Harrisburg 13x12 engine.
1—40 kw. 250 v. D.C. West.-Lycoming-simple 325 r.p.m. complete.
1—30 kw. 125 v. D.C. Gen. Elec. Marine Set. 305 r.p.m.

TRANSFORMERS

3—75 kw. Maloney transformers R.E. single phase 60 cy. oil cooled indoor—2200/220-110 v. NEW

ROTARY CONVERTER

1—300 kw. 250 v. D.C. 900 rev. cpd. wound 3 phase 60 cycle, 440 v, Westhse. Complete.

A. C. GENERATORS

No.	Kw.	Rpm.	Volts	Ph.	Type
1	300	450	2300	3	G. E. P.
2	150	600	220/440/220	3	Wagner
1	125	600	2300	3	G. E.
2	100	900	2300	3	G. E. P.
1	75	900	2300	3	G. E.
1	50	1200	220/440	3	G. E.

A. C. MOTORS—25 CYCLE, 3 PHASE

No.	Hp.	Volts	Rpm.	Type
1	125	440	480	Westg. CCL
2	150	440	480	Westg. CCL

A. C. MOTORS—3 PHASE, 60 CYCLE

No.	Hp.	Rpm.	Volts	Type
1	500	360	220/440	Westg. HF. sl.rg
1	400	450	2200	G. E. synch.
1	300	300	2200	Westghse. synch.
1	250	600	440	G. E. ATI. PB
1	200	600	2200	Westg. C. W.
6	200	514	2300/440	G. E. synch.
1	180	400	440/2300	Burke sl.gr. 3 brg.
2	175	600	220/440/2200	Wagner synch.
1	150	900	2300	G. E. synch
1	150	600	2300	G. E. synch
1	150	600	2200	Westg.sq. cage.
1	150	600	2200	G. E. MT. sl. ring.
1	150	600	2200	G. E. sl. ring.
1	150	1200	220	Elec. Machy. syn.
1	100	257	2300	G. E. synch.
1	100	900	2300	G. E., synchr.
1	75	600	220	G. E. sq. cg.
1	75	720	220	Westg., C.W.
1	75	490	440	Allis-Chal. S. R.
1	75	1800	2200	G. E. sq. cage.
1	75	900	2200	G. E. KT.
1	60	1200	220	G. E. sl. rg.
3	50	900	220	G. E. sq. cg.
1	50	900	2200	G. E. B.
1	50	1200	220/440	Wagner sl. rg.
1	40	1700	220/440	Westg. sl. rg.
1	25	1200	440	G. E. K
1	25	900	220	West C. S.
1	10	900	220	Westg. HF.
1	7½	900	220/440	G. E. MT.
2	2	1800	220/440	G. E.

(2 Phase Motors on request)

D. C. GENERATORS—250 VOLT

No.	Kw	Rpm.	Type
1	75	450	Diehl
1	50	600	Westg.
1	30	1000	Westg.
3	21	1250	Sprague

(Smaller sizes on request)

D. C. GENERATORS—125 VOLT

5, 10, 20, 22, 35, 50, 75, 2-100 kw.

D. C. MOTORS—230 VOLT

No.	Hp.	Rpm.	Type
1	150	1100	West. SK
1	100	625	Westg. type S
1	90	470	G. E. CL
1	80	500	Allis-Chalmers
3	75	475	Westg. type S
1	50	560	Westinghouse SK
1	50	200	Diehl
1	50	650	Sprague
1	40	400	Diehl
1	40	1300	Diehl
1	35	200	Diehl
1	35	700	Cr. Wheeler
1	35	420	Diehl
1	30	500	Diehl
1	25	600	Sprague
1	20	665	Diehl
1	20	200	Diehl
1	20	900	Diehl
1	15	1050	Cr. Wheeler CM
1	10	375/750	Westg. S var. sp.
8	10	1350	Rochester
1	7½	1150	Sprague C
1	5	1200	G. E. RC
1	3	1200	G. E. CVC

(Smaller sizes on request)

D. C. MOTORS—125 VOLT

1	20	650	G. E.
1	15	775	SK Westg.
1	5	700	Diehl
3	3	1100	G. E
2	3	1700	G. E.

HONESTLY REBUILT

LIQUIDATING

OUR LARGE STOCK

GUARANTEED GUARANTEED

A.C. and D.C. Motors.
Generators
Motor Generator Sets.
Electric Hoists.
Switchboards.
Synchronous Motors.
Starters.
Compensators.
Switches and Supplies.

PRICED TO SELL QUICKLY FOR CASH

WE SOLICIT YOUR INQUIRIES

WIRE—PHONE—OR WRITE

Miller-Owen Electric Co.

Incorporated

Pittsburgh, Penna.

ELECTRICAL MACHINERY

"Everything in Electric Power Machinery"

SAVE time and money. Buy rebuilt guaranteed equipment. Just as good as new—and you get what you want when you want it. Will quote with pleasure on the smallest motor or the largest, complete plant equipment.

WATCH FOR OUR SPECIAL OFFERINGS EACH WEEK

WANTED

Lot of 3 phase, 60 cycle, 220/440 volt Motors from 2 to 25 H.P. Will buy quick if price is right.

SPECIAL—75 H. P. General Electric, Type MT, Slip Ring Motor, 3 phase, 60 cycle, 220/440 volt, 720 r.p.m., complete with base, pulley drum controller and starting resistance.

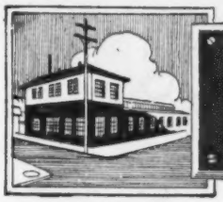
Price—f. o. b., Philadelphia—$750.00

Hundreds of Other Motors and Generators.

Remember, we will buy your surplus.

R. SCHEINERT CO.

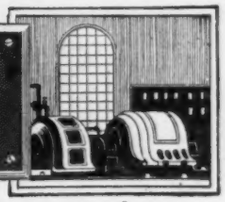
PHILADELPHIA



STEPHEN HALL & CO.

Incorporated

7th and Adams St's, Hoboken, N.J.



TELEPHONES: New York Direct Wire: Rector 3891; HOBOKEN 3750

New and Used Electrical Equipment—Condition Guaranteed—Ready to Ship

Slip Ring Motors—3-phase, 60-Cycle

h.p.	*Volts*	*Speed*	*Make*	*Type*
200	220–440	600	Westinghouse	CW
150	2200	600	General Electric	M
150	550	600	General Electric	M
150	220/440	600	General Electric	M
150	220/440	720	General Electric	M
100	2200	600	General Electric	M
100	2200	720	General Electric	M
100	440/220	720	General Electric	M
100	550	720	General Electric	M
100	440–220	600	General Electric	MT
100	440/220	900	General Electric	MTC
75	220/440	900	General Electric	M
75	550	900	General Electric	M
75	2200/440	720	General Electric	M
50	440/220	514	General Electric	M
50	550	900	General Electric	M
50	440/220	900	General Electric	M
50	440–220	600	General Electric	M
35	440/220	900	General Electric	M
35	550	900	General Electric	M
20	220/440	900	General Electric	M
15	220/440	720	General Electric	M
15	220–440	900	General Electric	M
10	220–440	1200	General Electric	MT
7½	220–440	900	General Electric	MT

DIRECT CURRENT MOTORS

175	115	575	Crocker-Wheeler	Interpole
125	230	545	Crocker-Wheeler	H
60	220	750	Westinghouse	S
55	115	845	General Electric	CLB
50	115	750	Westinghouse	SK
50	220	525	Westinghouse	S
40	220–550		Allis Chalmers	
35	220	575	Westinghouse	S
35	550	825	General Electric	DLC
30	220	575	Westinghouse	S
30	230	1150	General Electric	RC
30	230	1150	General Electric	RC
25	230	1150	General Electric	RC

Squirrel Cage—3-phase, 60-Cycle Motors

150	2200/440	720	General Electric	K
125	2200/440	720	General Electric	K
100	440/220	720	General Electric	K
100	440–220	900	General Electric	K
75	440/220	600	General Electric	K
75	440/220	720	General Electric	K
60	440/220	720	General Electric	KT
50	440/220	900	General Electric	K
50	220/440	1200	General Electric	K
40	440/220	900	General Electric	KT
35	440/220	600	General Electric	K
35	550	900	General Electric	K
35	220/440	900	General Electric	K
30	220/440	1200	General Electric	KT
25	440/220	900	General Electric	KT
25	220/440	720	General Electric	K
20	220/440	900	General Electric	K
15	220/440	900	General Electric	K

DIRECT CURRENT GENERATORS

Kw.	*Volts*	*Speed*	*Make*	*Type*
200	125	600	Crocker-Wheeler	Interpole
135	125	250	Wertinghouse	Interpole
50	125	850	Westinghouse	SK
45	125	975	General Electric	CLB
12	250	600	Westinghouse	SK
6	125	300	Westinghouse	SK

TRANSFORMERS

3—General Electric type H, form KDD, 100 kva., 6600–13,200 volt primary, 230–460 volt secondary, single phase, 60 cycle.

MOTOR GENERATOR SETS

1—220-kw., 250-v., 514-r.p.m., Westinghouse D.C. Generator connected to 300-kva., 2200-volt, 3-ph., 60-cy., Westinghouse syn. motor.

1—75-kw., 125-volt, 900-r.p.m., General Electric Type DLC, Generator connected to 110-hp., 220/440-volt., 3-ph., 60-cy., General Electric Form K motor.

SYNCHRONOUS MOTORS, 3-PH., 60-CY.

300	2200	450	Elec. Mchy. 3 bgs.

ALTERNATING CURRENT GENERATORS

1—200-kw., 720-r.p.m., 2300-volt, 3-ph., 60-cy General Electric type TRB with belted exciter.

1—150-kw., 600-r.p.m., 2300-volt, 3-ph., 60-cy. General Electric type ATB with belted exciter.

1—75-kw., 900-r.p.m., 2300-v., 3-ph., 60-cy. Gen. Elec. Type ATB, with belted exciter.

1—30-kva., 1200-r.p.m., 2300/440/220, 3-ph., 60-cy., Westinghouse with belted exciter.

TURBO-GENERATORS

2—500-kw., Westinghouse, 2300/550/440-volt, 3600-r.p.m., 3-ph., 60-cy. turbo-generators, with barometric condensers.

1—125-Kva., 240/480/550-v., 3-ph., 60-cy., 900 r.p.m., Westinghouse revolving field A.C. Generator with direct connected exciter, geared to a Westinghouse non-condensing 7200 r.p.m. turbine.

1—125-kw., Allis-Chalmers, 240-v., 3-ph., 60-cy., 3600-r.p.m., connected to Terry Steam Turbine with direct connected exciter.

1—35-kw. Westinghouse, 125/250-v., D. C., 1200 r.p.m., 3-wire, connected to 7200 r.p.m. Westinghouse geared turbine.

ENGINE GENERATOR SETS

1—75-kw., 250-125-v., 265 r.p.m., 3-wire Westinghouse connected to 13x12 Harrisburg Engine.

1—37½-kw., 125-volt, 300-r.p.m., Westinghouse D.C. Generator direct connected to 10x10 Harrisburg engine.

1—30-kw., 250-volt, 300 r.p.m. General Electric D.C. Generator direct connected to 10x10 Ames center crank engine.

If your requirements are not listed, write us, as we do not attempt to list our entire stock.

LAND

MOTOR BARGAINS

New and Used Selected Bargains

SLIP RING MOTORS

Hp.	*Make*	*Ph.*	*Cy.*	*Volts*	*Rpm.*
300	Allis-Chal.	3	60	220/440	870
200	Fair.-Morse	3	60	220/440	600

Others down to ½ hp.

SQUIRREL CAGE MOTORS

150	G.E.	3	25	440	375
150	G.E. (K.T.)	3	60	2200	870

Others down to ½ hp.

DIRECT CURRENT MOTORS

Hp.	*Make*	*Speed*
120	Sprague (C.)	450/900
100	Sprague (C.)	550/1100

Others down to ¼ hp.

Large stock of Motors from ¼ to 300 hp. Also Generators and Motor Generator Sets of all characteristics.

L. J. LAND, 207 Centre St., N. Y. C.

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1—6000 kw., 6600 volt, 3 phase, 60 cycle, 3600 r.p.m., General Electric condensing type. Only 5 years old.

1—1000 kw., .80 P. F., type ATB-2-1250-3600, form T, 3600 r.p.m., 3 phase, 60 cycle, 2300 volt, General Electric to 1000 kw. Curtis turbine.

2—600 kw., (750 kva.) 3 phase, 60 cycle, 3600 r.p.m., NEW General Electric: 1—480 volts: 1—2300 volts.

2—300 kw., (375 kva.) rigid frame type General Electric, 2300 volt, 3 phase, 60 cycle, 3600 r.p.m., condensing type.

1—250 kva., Unused, 220 volt, 3 phase, 60 cycle, 3600 r.p.m., Allis-Chalmers to a Moore condensing type turbine and direct connected exciter.

Very Large Stock Transformers, Turbines, Engine Driven Units, Motor Generators, Motors, Dynamos. All Descriptions.

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930 N. Third St., Philadelphia, Pa.

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America's Used Transformer Clearing House

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We carry a stock of approximately 2000 transformers of a total capacity of about 85,000 kva., in sizes from 1 to 1000 kva. and from 110 volts to 66,000 volts.

We specialize in the rewinding and repair of transformers, any size and any specifications. All work positively the best and guaranteed as such. We will show you a saving of from 30% to 60% of the cost of new transformers!

Send for our monthly bulletin, showing complete lists of transformers on hand, and our prices for rewinding transformers.

WE BUY MODERN TYPE TRANSFORMERS—ANY SIZE—ANY QUANTITY

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SALE OF NAVY SURPLUS
AND SURVEYED MATERIAL
By PUBLIC AUCTION
at the Naval Ordnance Plant, So. Charleston, W. Va.
at 10 a. m., 19 October, 1926
THE FOLLOWING MATERIAL WILL BE OFFERED:

Large quantity of electrical material including: 6 generators 189 electric motors from 2 to 400 H.P. and 210 Transformers.

100 Tons (approx.) Ferrous Metals

7 Frame Buildings and 1 Shed

3 Locomotive, 1 Auto, 3 Travelling and 2 misc. Cranes

1 Steel Water Tank, 100,000 gal. capacity

2 Electric and 1 Gasoline Locomotives

Large quantities of Pipe Fittings, Office Equipment and Hardware and Hand Tools

MACHINERY including Blower, Cutter, Drill Presses, Grinders, Lathes, Saws, Saw Tables, Planers, Hydraulic Presses, Turning Machines, Riveters, Slotting Machines, Boring Mills, Milling Machines, Concrete Mixers, Hoisting Engines, Tractors, Scrapers, Pumps and Furnaces.

ALSO MANY OTHER ITEMS

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230 VOLT—D. C.

1—125 hp. Gen. Elec. RC-17, interpole, 900 r.p.m.
1—125 hp. Crocker-Wheeler, CCD, comp'd, 450 r.p.m.
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1—90 hp. Gen. Elec. DLC 205, interpole, 850 r.p.m.
1—75 hp. Westing. SK-160, 850 r.p.m.
1—65 hp. Westing. SA, 600 r.p.m.
2—50/65 hp. G. E. RLC-206, 300/900 r.p.m.
1—50 hp. Westing. SK-140L, 975 r.p.m.
2—50 hp. Westing. SK-160, 565/1130 r.p.m.
1—40 hp. Westing. SK-130, 950 r.p.m.
2—20 hp. Westing. SK-90, 1100 r.p.m.
6—15 hp. Westing. SK-100L, 500/1500 r.p.m.
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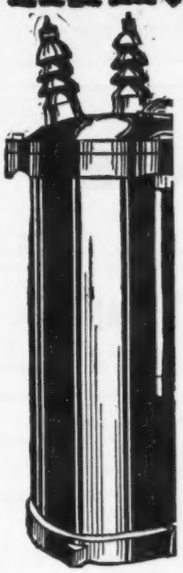

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Offered at

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2—200 hp. General Electric Synchronous (self-starting), 2300 volts, 500 r.p.m. Bare $1000.00 each.
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Also 2—used about 30 days.
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4—**Westinghouse Electric Motors,** direct current, rheostat and switchboard complete.

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All in First Class Condition.

Write for full particulars and prices.

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3—K-32, 45,000-v., 80/160 amp., indoor type current transformers.
6—K-9, 27,000-v. indoor type, 60/120 amp. current transformers.
8—K-9, 27,000-v., indoor type, 150/300 amp. current transformers.

CHOKE COILS

6—37,000-v., 600 amp., hour glass type choke coils.
3—50,000-v., 300 amp., hour glass type choke coils.

SWITCHES

1—K-24, 3 P.S.T., 300 amp., 35,000-v., General Electric Co. oil switch.
1—K-32, 800 amp., 15,000-v., 3 P.S.T., General Electric Co. switch.
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2500—KVA., BLEEDER TYPE
2—New 625 kva. with Condenser and above 60 cycle 3 ph.

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ASME CODE 200-lb. Never Erected.
Trans. M. G. Sets and Large Motors.

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1—NEW, 220-kw. General Electric, Type HCC, Form P, Rotary Converter, 125-250 volts, three wire, direct current, 1200 r.p.m. with 3—80 kva., single base transformers for 2300 volts A.C. complete with switchboards and instruments. All new material.

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Hoist, Crusher, Air Compressor and Dredge Motors

H.P.	*Speed*	*Ph.*	*Cy.*	*Type*	*Volts*
450	585	3	60	Sl. Rg.	440-220
400	514	3	60	Sl. Rg.	2200-550
300	514	3	60	Sl. Rg.	2300-550
3—225	1800	3	60	Sl. Rg.	550
2— 00	1800	3	60	Sl. Rg.	440-220
—200	500	3	25	Sl. Rg.	440-220 New
—250	750	3	25	Sl. Rg.	550
—200	750	3	25	Sl. Rg.	440-220
—200	235	3	25	Sl. Rg.	550-440-220 New
—200	214	3	25	G. E., Sl. Rg. Hoist, New	440-220
—?00	450			Cpd.	DC. 230
—175	214	3	25	Sl. Rg.	440-220
—150	235	3	25	Sl. Rg.	440-220 New
—150	500	3	25	Sl. Rg.	440-220 New
— 50	450			Cpd.	DC. 230
—100	214	3	25	Sl. Rg.	550-440-220
3— 75	750	3	25	Sl. Rg.	550-440-220
— 75	900-500	DC.		Int. Pole	230
— 35	575	DC.		230 Sht.	
2— 20	1200	3	60	Sl. Rg.	440-220 New
— 15	715	3	25	Crane	440-220
— 1?	1200	DC.		230 Cpd.	
— 10	715	3	25	Sl. Rg.	440-220
— 15	1200	3	60	Sl. Rg.	440-220
— 7½	1200	3	60	Sl. Rg.	440-220 New
— 7½	1800	3	60	Sl. Rg.	440-220 New
— 7½	1200-450	DC.			230
— 5	800-1500	DC.			230
— 2	1800	3	60	Sq.Cg.	Vertical 440
— 2	1200	3	60	Sl. Rg.	440-220
— 1	1100	3	60	Sl. Rg.	440-220
2	1200	3	60	Jenny Vert.	440-220
1	1100	3	60	S. I. Rg.	440-220
1	1800	3	60	Cr.-Wh.	440-220
1	1800	3	60	Allis-Ch.	440-220
1	1200	3	60	Allis Ch.	440-220
1	1200	3	60	A. C.	440-220
¾	1800	3	60	G. G., KT.	440-220
¾	1800	3	60	Wagner	440-220
¾	690	3	60	Richm'd Fan.	440-220
¼	850	3	60	ILG. Fan.	440-220
7½	1800	3	60	Imperial	550 New
22	715	3	25	G. E., Crane	440-220

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150 KW. MG Set, D C. 230, with either 60 cycle 220 v. or 25 cycle, 550-440 or 220 v. Sl. Rg. Motors

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300 new, General Electric, push button compensators. 25, 40 and 60 cy. Dealers send for list.

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8—823 hp. Babcock & Wilcox Stirling Water Tube Boilers, Class M-30, 200 lbs. pressure. Westinghouse stokers, forced draft fans. Vulcan soot blowers and all accessories.
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1—300 hp. Heine Water Tube Boilers, 160 lbs. pressure.

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Nashville Industrial Corporation
Old Hickory, Tennessee

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BARGAIN

Will Sell One or Both

2—150 hp., 265 r.p.m. **Skinner Tandem** Compound Engines direct connected to Westinghouse Generators of 100 kw., 250 v., 400 amp., 265 r.p.m.

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1—Bullock 260 Kva Alternating Current Generator, No. 16102, 683 amps., 220 volt, 3 ph., 60 cycle at 150 r.p.m. Direct connected to Buckeye 17½x24 high speed engine.

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Special Bargains

4—1000 kva. Westinghouse, single phase, 60 cy., O.I.S.C., 13,200/22,000 volt, Y primary, 6600/2200 volt secondary.

2—700 kva. General Electric, Type HTH, 3 ph., 25 cy., O.I.S.C., 6600/13,200 volt primary, 440/220 volt secondary.

3—75 kva. Maloney, Type HF, single phase, 60 cy., O.I.S.C., 2200 volt primary, 110/220 volt secondary.

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2 sets complete General Electric Electrolytic Cell with towers, 3 ph., 60 cy., Type I, form C-4-D.O. 27000/37900 v.

Less electrolyte and oil. Price $250 each f.o.b. Dayton, Ohio.

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Dayton, Ohio

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1—24x24 or larger **Coal Crusher.**
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100 to 150 kw., with transformers to transform 2300 v., 3 ph., 60 cy. current to 250/275 D.C. also switching equipment. Give detail description with name plate data, price wanted, delivery and shipping point.

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With transformers and switchboard equipment. 25 to 60 cycle or reverse.

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150 to 2000 kw. 550 or 250 volt.
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20 H. P. to 75 H. P.
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Squirrel Cage and Slip Ring

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3—500 kva., General Electric Generators, 2400 volt, 62½ cycle. Motor 6600 volt, 25 cycle.

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General Electric, 125-250 volt D.C., 25 cycle on A.C. side.
2—400 kw., 2—750 kw., 2—1500 kw., 2—2000 kw.

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Immediate Delivery at Material Saving

Size	Condr.	Volt	Size	Condr.	Volt
6	2	600	10	2	5,000
2	3	600	6	1	6,600
6	1	2,500	10	6	10,000
6	1	2,500	6	1	10,000
3/0	1	2,500	6	8	10,000
6	4	4,500	3/0	1	13,200
3/0	1	4,500	3/0	1	13,200

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2—100-hp. Worthingtons with Generators.

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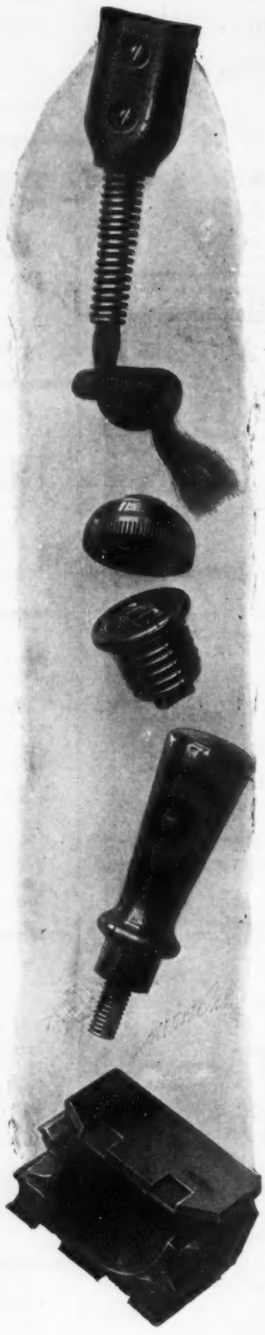

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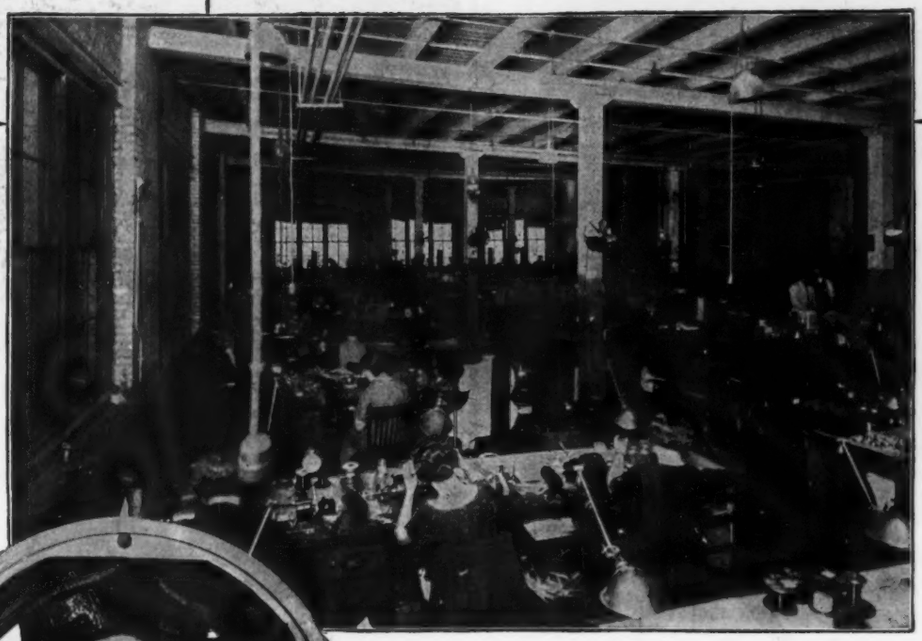

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Pipe Organ Magnets
Paper Section Coils
Impregnated Coils
Interweave Coils
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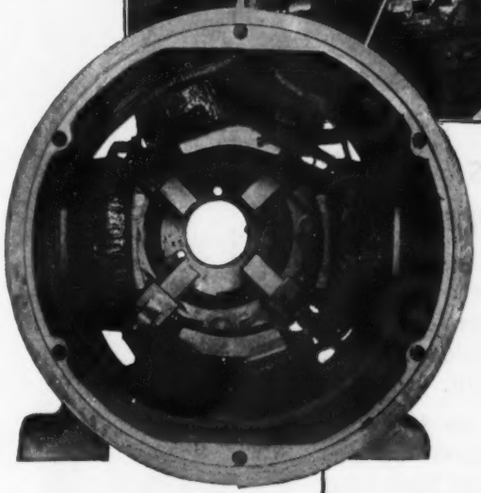
Radio Coils



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COIL winding is an art not quickly mastered. Not only must operators be trained to watch the many important details in winding a good coil, but much equipment and room is required for the many consecutive winding, impregnating and testing operations that are necessary in coil making.

Belden coil winding facilities are being constantly enlarged and improved to care for the increasing demand for Belden quality coils. Coils of every type are now being furnished, ranging from the small pipe organ magnets up to heavy field and transformer coils. Paper section coils for radio work are produced on automatic machines of new design that insure uniform production and quality.

Send us your coil specifications today and we shall be glad to quote you on any quantity by return mail.

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Please send us the Belden Booklet on Coil Windings.

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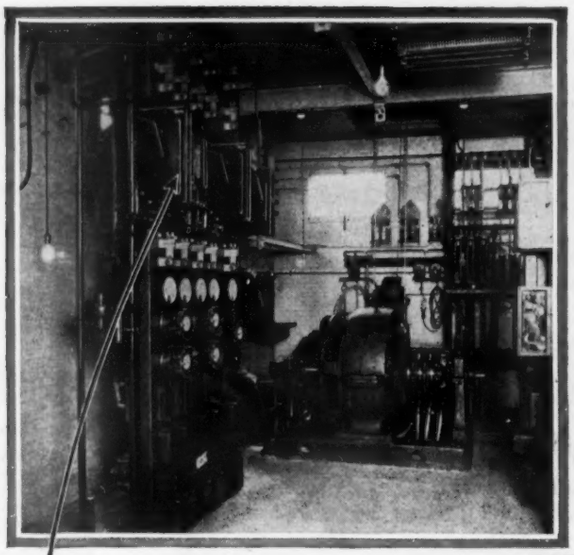

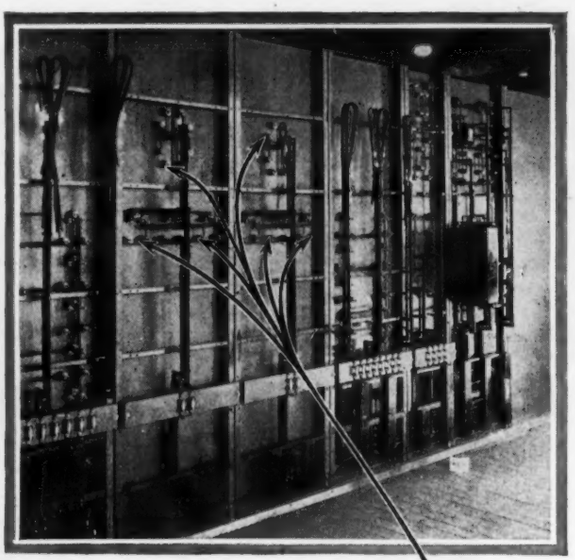

Bakelite barriers prevent "arcing-over"

"Arcing-over" between switches and from one circuit breaker to another is prevented by the use of Laminated Bakelite shields on this sub-station switchboard installation.

Thorough insulation of the lead-ins through the switchboard panels is also effected by the use of tubular bushings of laminated Bakelite.

Because of its high dielectric value, its great mechanical strength and of the ease with which it may be machined and drilled, laminated Bakelite is adapted to many insulation needs. Our engineers are ready to serve you in the solution of insulation problems.

Write for Booklet One.

BAKELITE CORPORATION

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BAKELITE CORPORATION OF CANADA, LTD., 163 Dufferin St., Toronto, Ont.

BAKELITE

REGISTERED U. S. PAT. OFF.

THE MATERIAL OF A THOUSAND USES

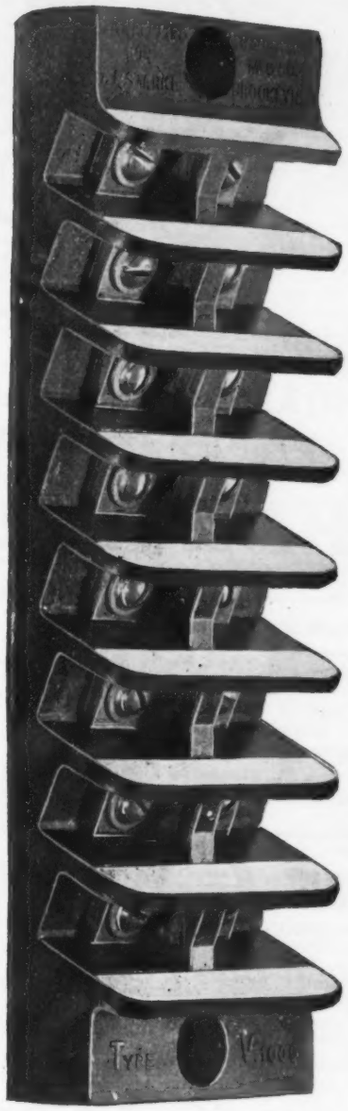
"The registered Trade Mark and Symbol shown above may be used only on products made from materials manufactured by Bakelite Corporation Under the capital "B" is the numerical sign for infinity, or unlimited quantity It symbolizes the infinite number of present and future uses of Bakelite Corporation's products."

HIGH TENSION INSULATORS

TRADE **ELECTROSE** MARK

REG. U. S. PAT. OFF. & FOREIGN COUNTRIES

MOULDED SPECIAL PARTS



The weather resisting high tension insulation

Electrose has been before the trade for many years. In fact it has grown up with the modern power boom and is firmly established in generating station service.

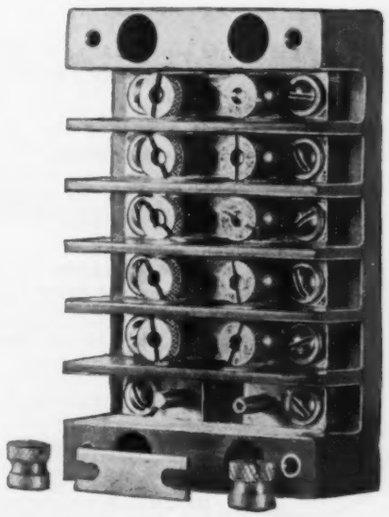
Electrose scored a triumph in outdoor insulation, proving beyond a doubt its superiority for moulded high tension insulation. At the same time its weather-resisting qualities—its remarkable indifference to vapor and dust-charged atmosphere gave it its place in central station construction.

Electrose terminal blocks are made in several sizes with various numbers of points. They are used and indorsed by the important utilities throughout the world.

Electrose lends itself admirably to such work. Panels for both low and high tensions mounting, bushings, etc. are molded easily and economically. Put it up to us. We gladly cooperate with you.

A new form of terminal block is shown at the left. This is developed to form a larger writing space for noting wire destinations and functions. This feature greatly simplifies testing and repairing. This block is now ready for general distribution in several sizes.

The block at right was made for use in the East Weymouth station of the Edison Illuminating Co. of Boston. The removable links enable the operator to make his tests quickly and easily. Information on all Electrose products on request.

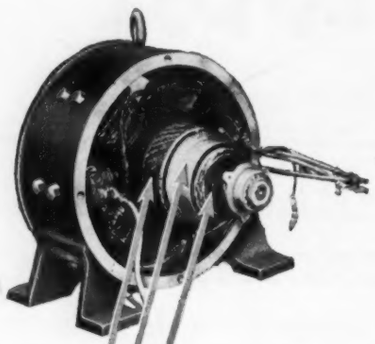


INSULATION MANUFACTURING COMPANY, INC.

70 Washington Street
BROOKLYN, N. Y.

Moulders of Bakelite and other materials—also a new material to replace turned wooden parts

The efficiency and length of service of every electrical product depends upon its insulation



A Safeguard *of* Long Life and Dependable Service

No matter the care and skill used in building an electrical product it can be no better than its insulation. Time and experience have proven that as an electrical insulator mica has no equal. The same two factors have proven that

MICABOND

is unequalled as a dependable insulator. MICABOND retains all of the natural advantages of raw mica and adds to their flexibility and dependability. MICABOND is made in a form to fill every insulating need —plate, sheet, segments, rings, tubes, washers, etc.

Quick service on specially moulded or punched parts in any quantity. Write for samples and prices.

MICABOND "V" RINGS

One or two-piece rings, made in thicknesses of $\frac{1}{32}$" to $\frac{1}{16}$"—and in sizes of ¾" to 30" O. D.—punched or moulded to close tolerances.

MICABOND SEGMENTS

Of India and Amber mica, 3% to 5% binder, held to close tolerances, will withstand puncture voltage of 900 volts per mil of thickness. Sawed or punched to any size.

MICABOND TAPE

For wrapping field coils. Can be wound around small turns and sharp corners without breaking or cracking. High mechanical and dielectric strength. Furnished in either India or Amber mica. Unrolls easily without tearing. ¾" wide, 100' long, packed in tin containers.

Chicago Mica Co.

430 CAMPBELL STREET
VALPARAISO, IND.

(15)

AIMco

Radio-Coil-Winder
for low-loss basket-weave single or double circuit
RADIO INDUCTANCES
Also other winders

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"American" AIMco INSULATING MACHINERY COMPANY
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PHILADELPHIA PENNSYLVANIA U.S.A.

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CLEAN INSIDE—Made in our own open hearth furnaces, using the latest and most progressive methods to get good clean steel.

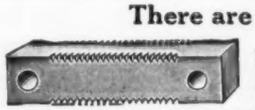
CLEAN OUTSIDE—Rolled and treated with utmost care to obtain high quality and uniformity in all respects.

RESULTS—Better magnetic performance, best die service.

MANSFIELD SHEET & TIN PLATE CO., MANSFIELD, O.

ELECTRICAL SHEETS

There are reasons why



LAVA insulation is so often specified by the manufacturers of highest quality instruments and appliances.

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AMERICAN LAVA CORPORATION
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"COPPERWELD"
WIRE—STRAND—RODS

ARISTOS COPPERWELD

There is no other "copper-covered steel" or "copper-clad steel" made like COPPERWELD—by the Molten Welding Process.

IT CANNOT RUST

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If you want competent and efficient assistants, experienced in the field served by this journal, you will naturally find such men among our readers—which include the keenest and most progressive men in the industry.

Get in touch with a number of these men and select the one that is best suited for your needs.

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Only $2.00 for 25 words 806

A good Electrical Sheet the foundation of a good motor

Newport Electrical Sheets meet these specifications:

1. *Balance.* All Newport sheets are uniform in thickness and annealing, assuring correct weight distribution.
2. *Accurate dimensions.* Since Newport Electrical Sheets are accurate to gauge, the finished core is also accurate.
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Our engineers will be glad to talk it over with you. Get in touch with them.

THE NEWPORT ROLLING MILL CO.

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ELECTRICAL SHEETS

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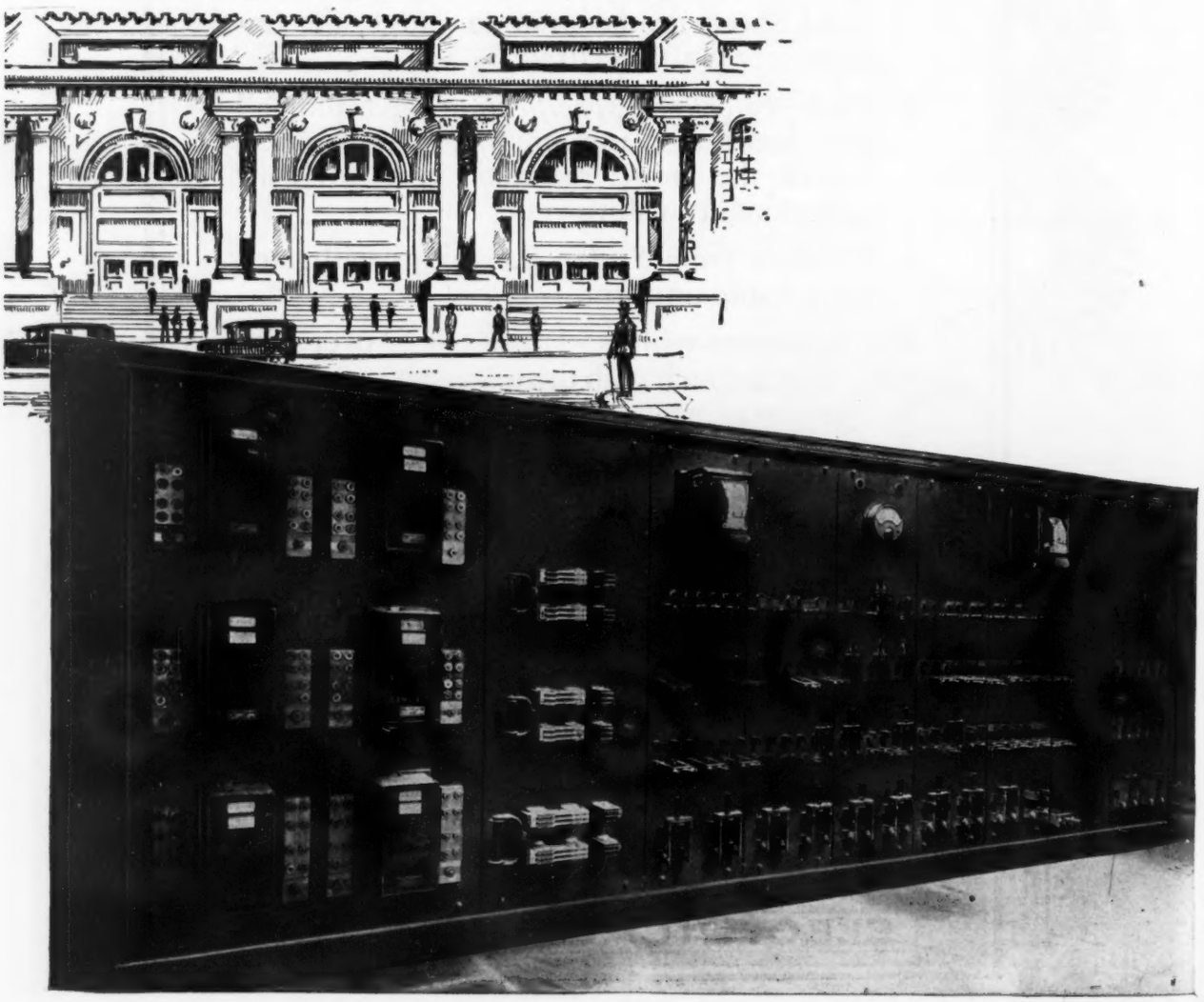
in New York's Show Places

The Metropolitan Museum of Art, one of New York's show places has an elaborate switchboard of Portland Monson Slate. For every type of switchboard service, the uniform and superior quality of this slate has contributed greatly to economical and continuous operation.

20 years of service to the electrical industry without the rejection of one piece of slate because of defects in its insulating qualities.

Enlarged facilities insure prompt and efficient service. Consult us—let us quote on your needs.

Portland-Monson Slate Co.
Portland, Me.
Quarries at Monson, Me.



12 points to look for in an insulator

Point No. 8

Spaulding Hard Fibre:

1. Won't split, break, dent, sliver or chip.
2. Non-conductor of electricity.
3. Possesses great tensile and compression strength.
4. Easily machined.
5. Weight for weight—twice as strong as steel.
6. Light weight.
7. Does not deteriorate with age.
8. **Impervious to oils, gases and organic solvents.**
9. Resists heat (up to 300° Fahr.)
10. Wears longer.
11. Non-conductor of heat.
12. Comparatively low cost.

Unaffected by Oils, Acids, Alkalis and Solvents

AFTER three months immersion in lubricating oils and gasoline, SPAULDING Super-Grey Fibre was unchanged in weight and thickness.

Immersion for periods of one to three months in organic acids and alkalis, chemical salt solutions, weak acids and alkalis, strong mineral acids in dilute solutions (nine parts water to one part or less of concentrated acid) showed no other effects on SPAULDING HARD FIBRE than when immersed in pure water.

If you require a perfectly inert material with dielectric strength of 200-400 volts per 1/1000 of an inch thickness plus great tensile strength, send for samples of SPAULDING HARD FIBRE and make your own tests.

Spaulding HARD FIBRE

Spaulding -BAKELITE

Where electrical resistance greater than that possessed by fibre is required, use SPAULDING—BAKELITE.

It combines the good qualities of many materials with several properties which are essentially its own. It is a laminated phenolic condensation product that possesses high dielectric properties and great strength—resists heat and cold, will not absorb water—is impervious to dilute acids, salt water and steam—is not soluble in most of the ordinary solvents and will not deteriorate with time or exposure.

Send for samples and prices

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659 W. Lake St., Chicago
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You Can Use
Vulcanized Fibre
If It Is
Continental
Grade 25

For the first time in history a vulcanized fibre has been made that can be—

FORMED
in Forming Dies
SPUN
like Soft Metal

Think what this means! You can save money and improve your product.

WRITE OR WIRE

and we will be glad to have our engineers call and discuss the many advantages of Continental Vulcanized Fibre Grade 25.

THE CONTINENTAL FIBRE CO.

Factory: NEWARK, DELAWARE

Service on Dilecto, also Contex, Conite and Vulcanized Fibre, from:

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CONTINENTAL
Vulcanized
FIBRE 25

*These shapes were formed COLD from Continental Vulcanized Fibre Grade 25.

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RUBBER COVERED WIRE
for INTERIOR WIRING

Highest Standard of Excellence
Send for descriptive book

American Steel & Wire Company
Chicago - New York

THE WORLD'S STANDARD

"IRVINGTON"

Black and Yellow
Varnished Silk, Varnished Cambric, Varnished Paper

Irv-O-Slot Insulation Flexible Varnished Tubing
Insulating Varnishes and Compounds

Irvington Varnish & Insulator Co.
Irvington, N. J.

Sales Representatives in the Principal Cities

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RUBBER—PAPER—CAMBRIC
INSULATED CABLES

SAFETY CABLE CO.
NEW YORK
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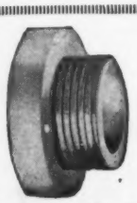
REELS

Continuous contact for portable machinery. Hand wound. Spring wound. Counter weight wound. Heavy Duty Plugs and Receptacles.

J. L. GLEASON & CO.
241 Franklin St., Boston, Mass.



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High Grade—Heat Resisting
Machined as Accurately as Brass
INSULATION
D. M. STEWARD MFG. CO.
Chattanooga, Tenn.

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"Okonite," "Manson" and Dundee "A," "B" Tapes
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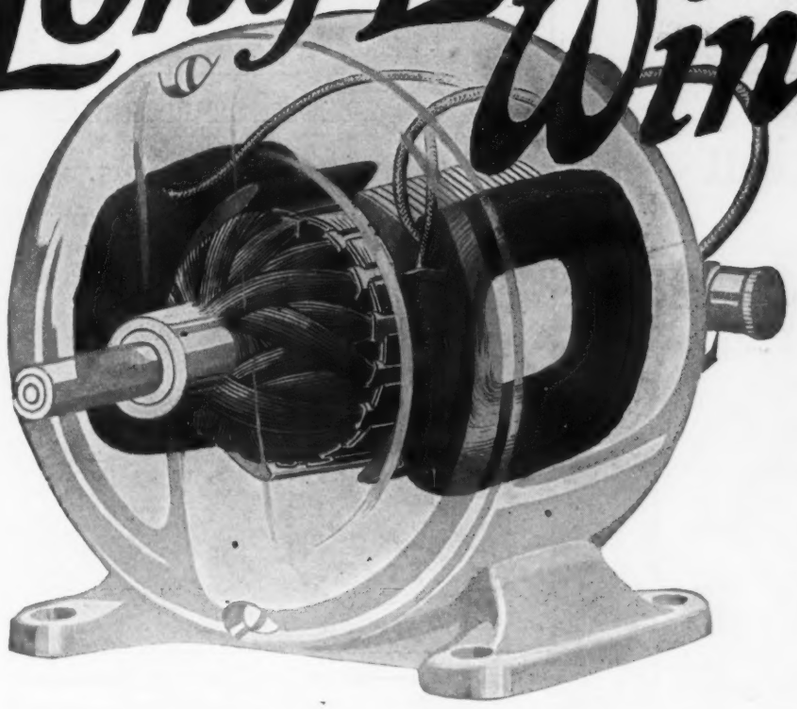
Long-Lived Windings



make Long-Lived Motors

DUDLO

The life of any motor is measured by the durability of its windings. The life of DUDLO Windings is insured through the durability of the wire, particularly the insulation, upon which winding efficiency depends. Manufacturers of fractional horse power motors for all kinds of domestic and industrial equipment will insure the longest possible life for their motors through the use of Dudlo Magnet Wire and Field Coils.

The Dudlo experimental and engineering departments are at the service of any manufacturer, fully and freely, without obligation of any kind.

DUDLO

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160 North La Salle Street CHICAGO, ILL.
4153 Bingham Ave. ST. LOUIS MO.
274 Brannan St. SAN FRANCISCO, CALIFORNIA

Fused Pure Silica
Vitreosil

Central Station Men!

You realize the value of the complicated instruments used to record temperatures, operate thermal relays, regulate frequency and demands, etc. You know, also, how necessary a test department is to maintain these instruments in proper condition.

Constant resistance and non-expansive qualities are essential to correct resistance values and therefore to the indicated readings.

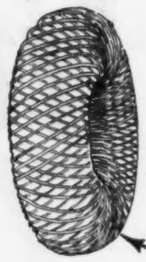
Vitreosil fills the bill here exactly. Non-hygroscopic, with a coefficient of expansion which can be ignored, even on minute indications. These two qualities furnish freedom from resistance variation, and a perfect foundation for all thermal units.

Now consider that vitreosil is the *only* material which furnishes reliable insulation at temperatures above 500° C. and on up to 1000° C.!

Will it pay you to specify vitreosil insulation in important units?

Think it over.

The Thermal Syndicate, Ltd.
1716 Atlantic Avenue
Brooklyn, N. Y.



COILS *for* RADIO

Balloon Honeycombs
Wave Wound Spirals
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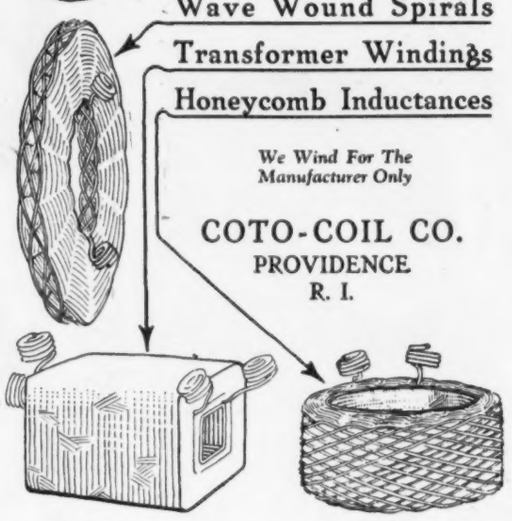
We Wind For The Manufacturer Only

COTO-COIL CO.
PROVIDENCE
R. I.



"American Brand"

Weatherproof Wire and Cables,
Bare Copper Wire and Cables
has no equal for long, satisfactory, economical service.

American Insulated Wire and Cable Co.
21st, Sangamon and Morgan Sts., Chicago

SAMSON SPOT CORD
FOR HANGING ARC LAMPS

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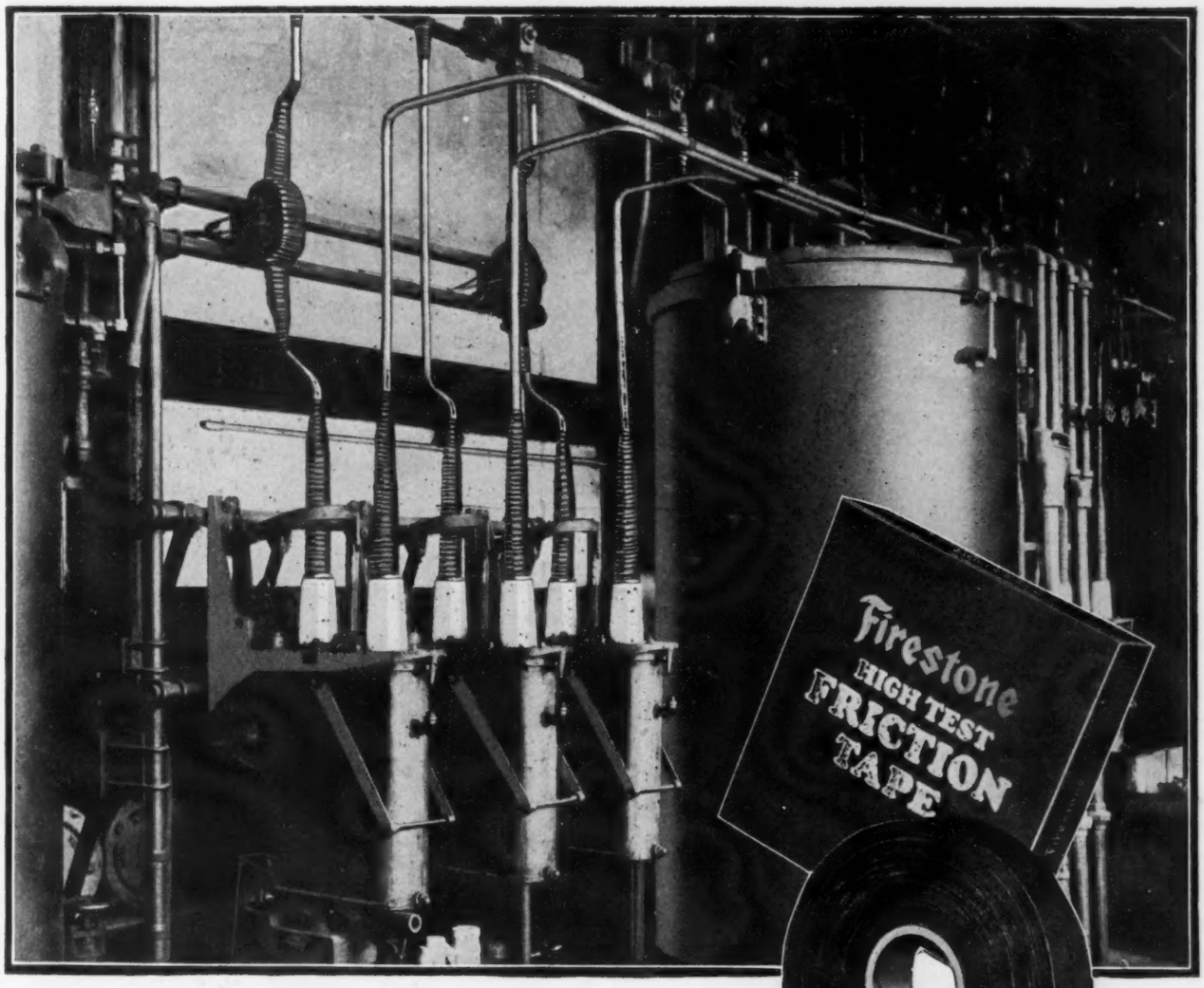
SOLID BRAIDED COTTON—WATER PROOFED
Send for Catalogue and Samples
SAMSON CORDAGE WORKS, BOSTON, MASS.

Your Name
in this space in all issues where larger display space is not used backs up your advertising campaign and keeps your name in the alphabetical index.



Tape used on 2300 volt oil circuit breaker used on the primary side of the transformer in the picture.

Friction Tape that Minimizes Leakage

Pinholes in friction tape cause current leakage with subsequent short circuits. Laboratory tests of Firestone Friction Tape show 1.9 pinholes, instead of 6 pinholes, to every 3 yards, as permitted in the specifications of the American Society for Testing Materials, the bureau that determines uniformity of products.

Such a minimum of pinholes indicates first, firm-woven cotton sheeting; second, the use of superior compound that readily lends itself to calendering, and third, good frictioning. When Firestone Friction Tape is unrolled, the rubber stock does not pull off.

Order this dependable friction tape now—so you can supply local electrical contractors and manufacturers. Prices, specifications, etc., may be had from nearest branch or direct from Akron.

The Mark of Quality

Firestone
FRICTION TAPE

AMERICANS SHOULD PRODUCE THEIR OWN RUBBER . . Harvey S. Firestone

INDESTRUCTIBLE

Fibre of the better kind

Sheets—Tubes—Rods—Special Shapes.
For Electrical Parts.
For Mechanical Parts.
Stronger than steel. Lighter than metals.
Will not split, dent, break or crack.
Good non-conductor and impervious to oils, etc. And the cost is very low.
That's our fibre. Let us quote you. Send specifications.
We want your business.
Standard Fibre Products Co., 50 Pleasant St.,
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Volts and Kilo-Volts

but no harm to

HYDRO-PROOF TAPE
REGISTERED U.S. PATENT OFFICE

Repeated tests in laboratories outside our factory have shown that Hydro-Proof Tape will stand higher voltage than it would ever be used against.

One layer breaks down at 8 kv.

This is one feature of the "guarantee of perfect insulation" offered by Hydro-Proof Tape. In di-electric strength, also adhesion, tensile strength, resistance to age, heat, cold, rain and underground dampness it offers.

Requirements Plus

Write for the folder "A Guarantee of Perfect Insulation"

ELKHART RUBBER WORKS
Elkhart, Indiana

WEATHERPROOF
RUBBER COVERED
SLOW BURNING
BARE COPPER WIRE

TRADE "O.K." MARK — WEATHERPROOF WIRES AND CABLES
TRADE "PARAC" MARK — RUBBER COVERED WIRES AND CABLES

PHILLIPS WIRE COMPANY
PAWTUCKET, R. I.

They Must Not Fail

CONTACT Points, of all things, must be absolutely reliable—so much depends upon their proper functioning. Long experience and extra care in manufacturing have made Baker Contact Points the safe, reliable units they are. They may be had of Platinum, Iridio-Platinum, Silver and Special Alloys. We shall be glad to send you detailed descriptions.

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John A. Roebling's Sons Company
Trenton, New Jersey J-1707

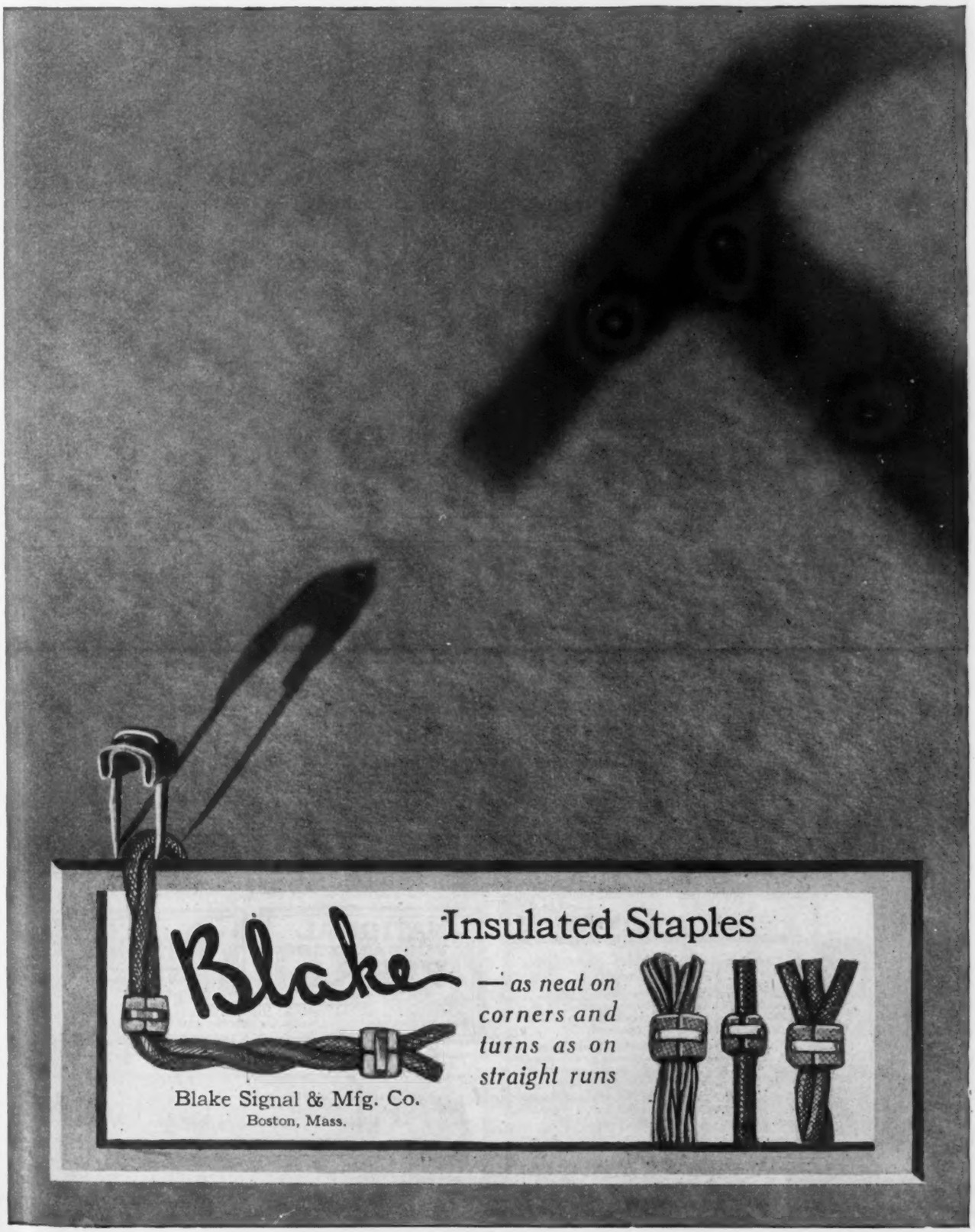
DeCeleCo Fabricated Transite *and* Asbestos Ebony

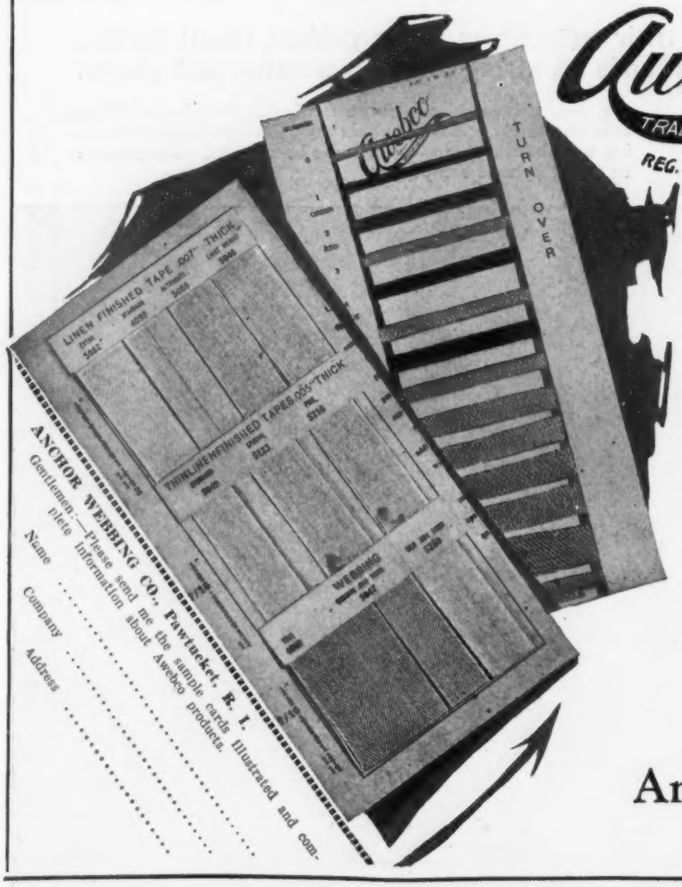
Assures you (1) prompt service with a saving of time and money (2) finest quality of material and workmanship (3) and relief from your troubles in working it yourself.
Don't wait any longer, let us help you today.

DeCeleCo *Incorporated* 1540 Anna Place, Detroit, Mich.

Telephone Companies are appealing to their subscribers to be patient about service interruptions due to short circuits and grounds on wiring in damp weather and places.

BLAKE Insulated Staples the *only* driven wire support for inside telephone wiring that absolutely prevent such service interruptions, so annoying to subscribers, so troublesome to find and so expensive to the telephone company.





Awebco

TRADE MARK
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Superior tapes and webbing for electrical uses

Awebco loom goods are made from the finest linen, cotton and silk threads.

Awebco tape is used for the protection of low tension busses and all exposed conductors and joints. Its convenience and economy have given it a universal preference. The sleeving covers bare wires and equipment wiring. It is strong and easy to handle.

Awebco webbing keeps the cable banks in line and assures neat, compact cable runs.

The cards illustrated contain actual samples of Awebco products and charts for reference.

Use the coupon.

Anchor Webbing Company

Pawtucket, R. I.

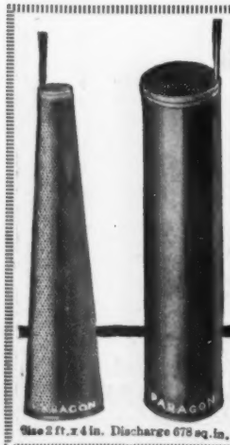
MAGNET WIRE

MARING PROCESS

WE offer the *Nation's finest value in Magnet Wire*—enamel, silk or cotton covered. "The Maring Process" assures that much-desired uniformity in quality.

MARING WIRE COMPANY

Factory and General Offices
MUSKEGON, MICHIGAN



Size 2 ft. x 4 in. Discharge 678 sq. in.

Paragon Grounds

Low Resistance. High Conductivity. Ample Capacity.

A plain, common-sense, inexpensive device accurately designed, carefully constructed of pure continuous copper throughout with no soldered or mechanical joints under ground.

Furnish adequate, dependable, durable grounding. Protect dependably valuable electric equipment from lightning, high tension crossed and other excess potential.

Complete directions for accurately and conveniently installing to insure efficiency of operation accompany every shipment.

PARAGON ELECTRIC CO.

Dearborn and Van Buren Streets
CHICAGO

NATIONAL VULCANIZED FIBRE

PHENOLITE

Laminated BAKELITE

National Vulcanized Fibre Co., Wilmington, Del., U. S. A.
We operate six great plants and maintain sales and service offices in New York, Chicago, Boston, Philadelphia, Pittsburgh, Cleveland, Milwaukee, Los Angeles, San Francisco, Detroit, Rochester, Birmingham, Denver, Seattle, Toronto, Greenville, St. Louis, Baltimore, New Haven

HARD PORCELAIN

For Electrical Specialties

IMPERIAL PORCELAIN WORKS

TRENTON, N. J

Asbestos Ebony

Asbestos Ebony Panels, Central Fire Alarm System, Los Angeles, Cal. Installation by Brown & Pengilly.

3-in. holes on 7-in. centers

What other insulating base could stand it?

EVERY panel of the Asbestos Ebony fire alarm signal switchboard above is drilled with 3 in. holes on 7 in. centers.

Use of an ordinary switchboard material would probably necessitate at least 50% greater spacing, with material 1½ in. instead of 1 in. thickness.

Engineers everywhere are utilizing the remarkable electrical and mechanical strength of Asbestos Ebony to get greater economy and dependability. As it is a manufactured material, they know it is uniform and free from flaws.

JOHNS-MANVILLE INC., 292 MADISON AVENUE AT 41st STREET, NEW YORK CITY
Branches in All Large Cities. For Canada: CANADIAN JOHNS-MANVILLE CO., Ltd., TORONTO

JOHNS-MANVILLE

Through — Electrical Materials for Utilities Jobber Contractor and Dealer

Time Tested!

HAZARD PRODUCTS

Include:

Parkway Cable
Submarine Cable
Fire Alarm Cable
Spiralweave Cable
Lead Encased Cable
Railroad Signal Wire
Mining Machine Cable
Spiralweave Tree Wire
Locomotive Headlight Wire
Hazard All-Rubber Cable
Borehole or Shaft Power Cable
Spiralweave Portable Cord
Loreca Arc Welding Cable

Long-life Wires and Cables with high factor of safety

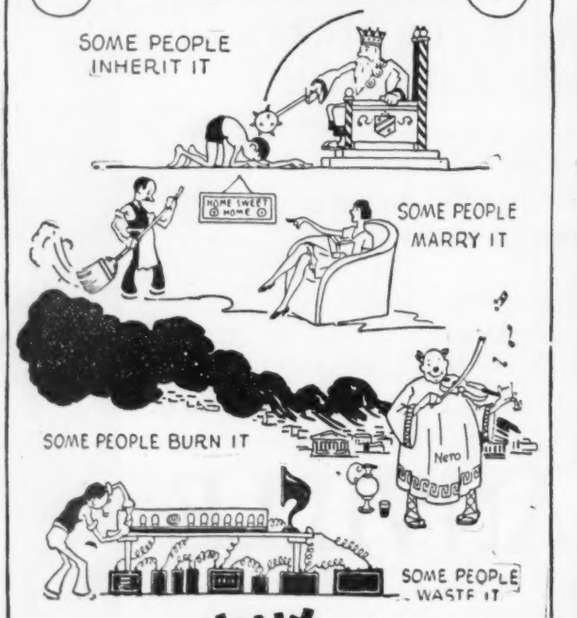
The Hazard line of wires and cables for practically every requirement has been developed through 25 years of careful study of operating conditions and requirements. They are designed with a high factor of safety and will give years and years of dependable service without failure.

Learn about the many advantageous features of Hazard Wires and Cables—ask for complete information on any of the products listed at the left.

Hazard Mfg. Company
Wilkes-Barre, Pa.
New York Pittsburgh Chicago Denver Birmingham

HAZARD
RUBBER INSULATED
WIRES & CABLES

POWER



but
ILLINOIS INSULATORS SAVE IT

OVER thirty years' use has proved Orangeburg Fibre Conduit the most economical, safest and most reliable underground duct. Two factories assure prompt service and deliveries.

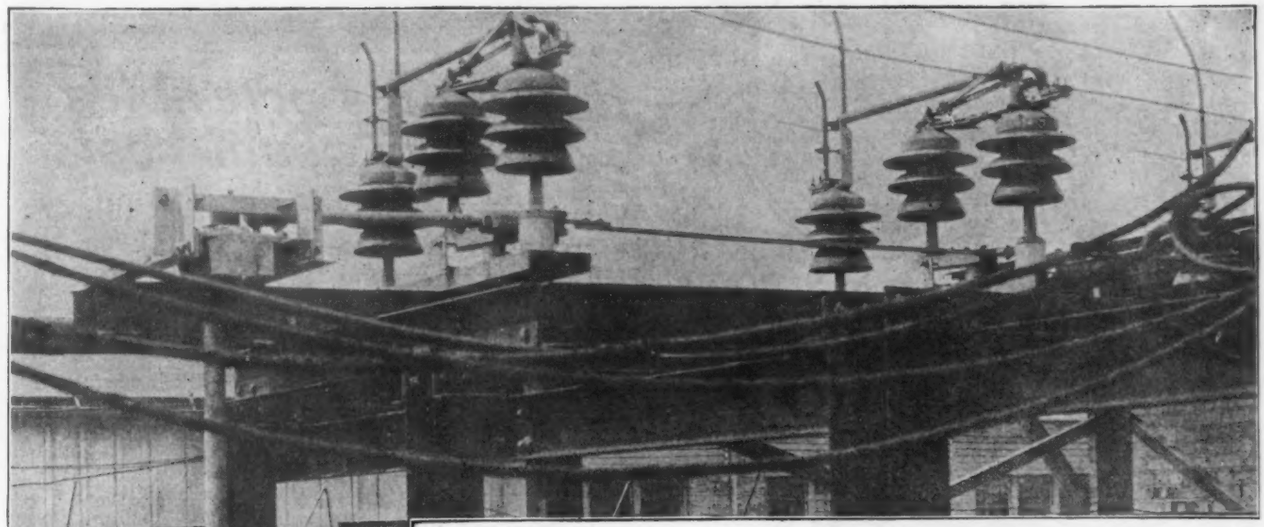
Johns-Manville, Inc.
Sole Selling Agent for the Fibre Conduit Co.

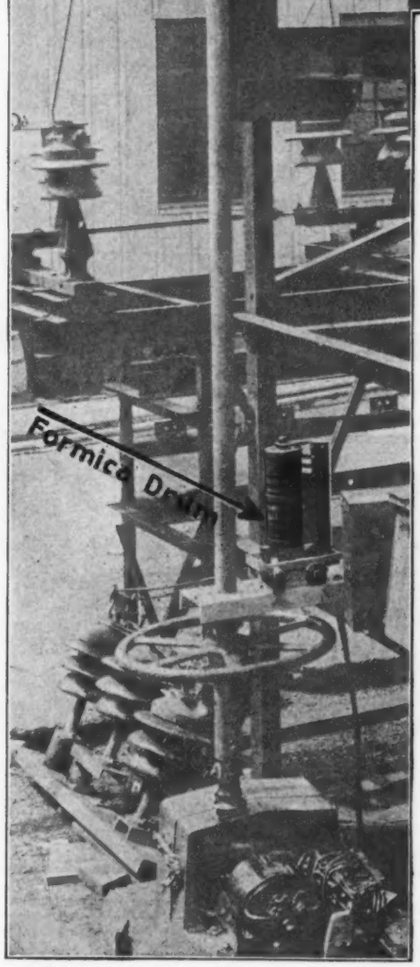
ORANGEBURG
FIBRE CONDUIT

ELECTRICAL ENGINEERS EQUIPMENT CO. THREE E CHICAGO, U.S.A. THE MARK OF QUALITY

"THREE E"
HIGH QUALITY
LINE AND STATION EQUIPMENT
Electrical Engineers Equipment Co.
General Offices: 711 Meridian St., Chicago, Ill.
Sales Offices in all principal cities

Milliken
Radio and Transmission
Towers
Milliken Brothers Mfg. Co., Inc.,
Suite 407, No. 26 Park Place, New York, N.Y.





Insulation That Stands the Gaff

FORMICA tubing, rods, and machined parts stand difficult conditions - - outdoors or in.

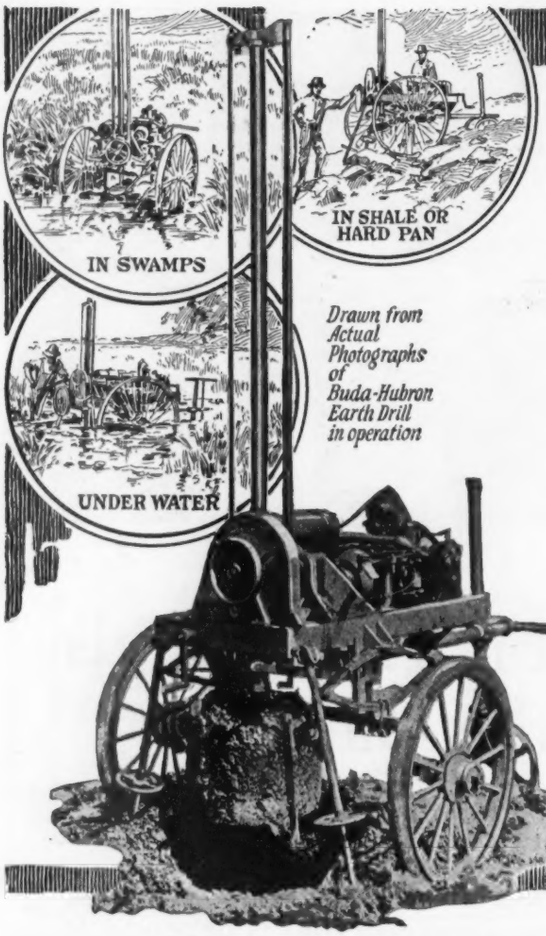
It is an insulation adapted to high voltages, high frequencies - - and one that is dependable because it has high mechanical as well as insulation strength. It is stable, does not warp, swell or change its dimensions - - - is not affected by humidity or moderate heat.

It is used by makers of high tension equipment, by central stations, and in motors, instruments, and electrical devices of every character.

A large equipment in the hands of a specialized organization permits quick delivery of your requirements. Send your next order to Cincinnati and try the service.

THE FORMICA INSULATION CO.
4626 Spring Grove Avenue Cincinnati, Ohio

FORMICA
Made from Anhydrous Bakelite Resins
SHEETS TUBES RODS



Drawn from Actual Photographs of Buda-Hubron Earth Drill in operation

— and it digs pole holes at 1/5 the usual cost

Wherever holes are located, on side hills, in swamps under water—through hard pan, clay or frozen ground, the Buda-Hubron Earth Drill digs them speedily, easily and economically.

One company with three Buda-Hubron drills in operation writes: "Replacing the old-fashioned hand-methods by this machine has enabled us to dig post holes at about one-fifth their former cost."

The Buda-Hubron is built for hard service, and both construction and performance are guaranteed by a company with 45 years' experience in machine construction.

Write us for Descriptive Bulletin 548-L and cost data from users in various parts of the country.

THE BUDA COMPANY
HARVEY (Chicago Suburb) ILLINOIS

Digs a pole hole 6 ft. deep in 3 minutes.

BUDA ESTABLISHED 1881

AMERICAN BRIDGE COMPANY

EMPIRE BUILDING—71 BROADWAY NEW YORK, N. Y.

Manufacturers of Steel Structures of all classes particularly BRIDGES AND BUILDINGS

ALSO STEEL BARGES FOR HARBORS AND RIVERS, STEEL TOWERS FOR ELECTRIC TRANSMISSION, HEROULT ELECTRIC FURNACES, ETC.

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Pacific Coast Representative: U. S. Steel Products Co., Pacific Coast Dept. — San Francisco, Cal. · Los Angeles, Cal. · Portland, Ore. · Seattle, Wash.

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SPECIAL TRANSFORMERS

BUILT TO ORDER

for Engineers and Experimenters

As the largest manufacturers of small transformers, we are equipped to build special small transformers of any type. Engineers and experimenters desiring transformers made up specially for their requirements are invited to write us.

Jefferson Electric Mfg. Co.

Largest manufacturers of small transformers

504 SO. GREEN ST. CHICAGO, ILL. U.S.A.

HIGH TENSION
PORCELAIN INSULATORS
A QUALITY PRODUCT
COOK PORCELAIN INSULATOR CORP.
CAMBRIDGE, OHIO.

BELL
NORTHERN CEDAR POLES WESTERN
BUTT TREATING ANY KIND REQUIRED
BELL LUMBER CO., *Minneapolis, Minn.*

HEXSULATE

Trade Mark Reg. U.S. Pat. Off.

An Excellent Wire-Covering Saturant that is Weatherproof

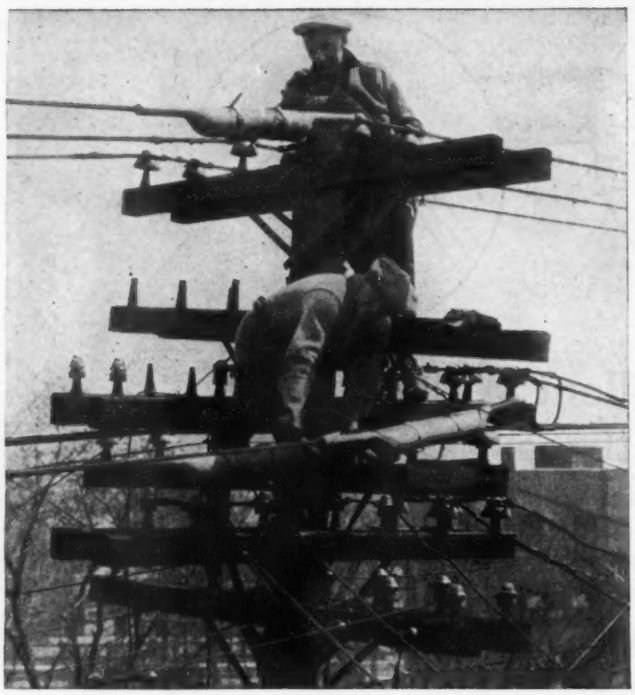
Hexsulate is an ideal weatherproof wire covering saturant. According to the ETL report it has many virtues not commonly found in other saturants.

1. HEXSULATE is very liquid at 250° to 260° F.
   Results: Thorough penetration.
2. HEXSULATE has high dielectric strength.
   Results: Good insulation.
3. HEXSULATE is very impervious to weather elements.
   Results: Durability.
4. HEXSULATE resists fungus. It is especially adapted for southern climate.
   Results: Long life.

Samples and quotations gladly submitted on request, also certified copy of dielectric strength test, etc.

TAR PRODUCTS CORPORATION
Providence, Rhode Island

Check Up!



Be Sure Your Men Have Enough "Pigs"

Don't just assume that your line crews have a sufficient number of Marshall's Shields for complete protection on hot line work.

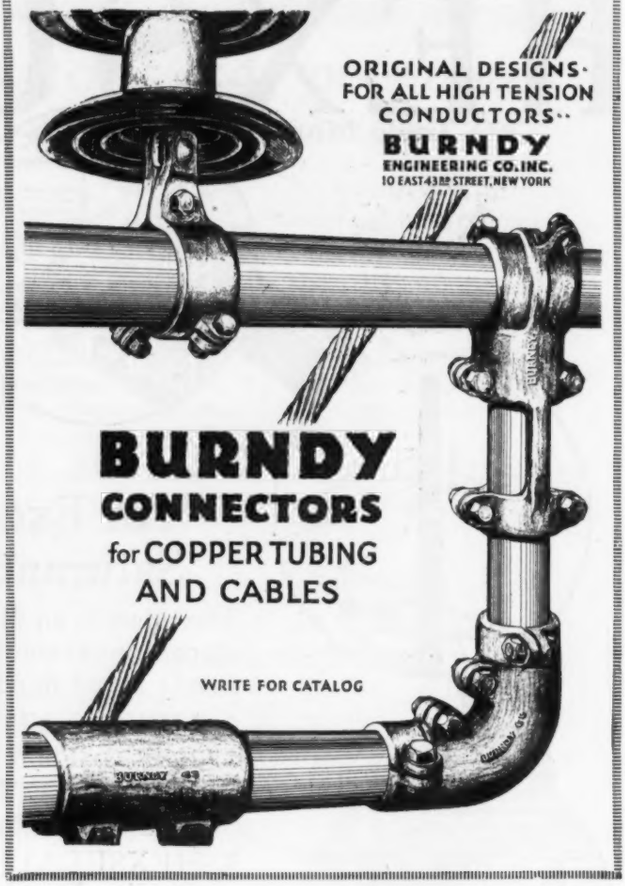
Order a check-up! It is in your interest as well as theirs.

An accident is costly in loss of time, in shaken morale, and in destruction or tie-up of equipment.

To promote safety in hot line work, the makers of Marshall's Linemen's Shields have prepared a booklet for you or your men—*"A Guide to Safety for Your Linemen."* Send for it. It is free.

MARSHALL'S
LINEMEN'S
SHIELDS

Linemen Protector Company
2052 Penobscot Bldg., Detroit, Mich.

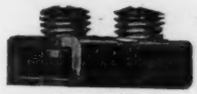


STEEL STRUCTURES
for
Transmission Lines
To Meet Every Requirement
AERMOTOR CO.
Chicago

BOWIE HIGH VOLTAGE EQUIPMENT
CUT OUTS—AIR BREAKS—DISCONNECTS—FUSES
Send for Bulletin
BOWIE SWITCH CO.
85 Second St., SAN FRANCISCO
E. G. Hatch Co., 2 Rector St., New York; R. Notvest, 6411 St. Claire Ave., Cleveland; Oliver J. Nilsen & Co., 45 Bourke St., Melbourne.

Steel Transmission Towers
RITER-CONLEY COMPANY
Pittsburgh

Cross Section Showing Bridge



Corner View

Top View

For Economy and Ease of Installation

SHERMAN Fixture Connectors

PATENTED — APPROVED

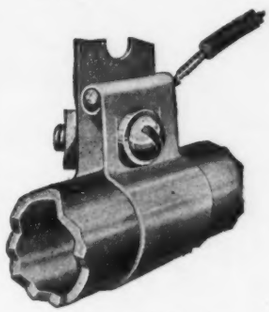
FOR CONNECTING ALL SMALL WIRES

A Perfect Connector— Electrically *and* Mechanically

Sherman Fixture Connectors are most practical—they require only tape—and a safe electrical joint must be taped. They are the only practical solderless connectors—solderless wiring is now standard practice. They save money because they more than pay their cost in time saved. Sherman Fixture Connectors have been in use for years and have been established as the perfect Solderless Connectors.

Points of Merit

- Screws cannot come out.
- One size only—takes all wires.
- Avoids dangerous practice of twisting together stranded and solid wires.
- All Brass—perfect conductivity. Unbreakable.
- Wires cannot go in wrong place. Instant perfect connection in the dark.
- Quickest to use.
- Favored by inspectors—quickest to inspect and safest joint.
- Strongest joint — cannot jar loose by vibration.
- Cheapest — costs less than nothing. Time saving more than pays cost.
- Nationally accepted as standard practice.

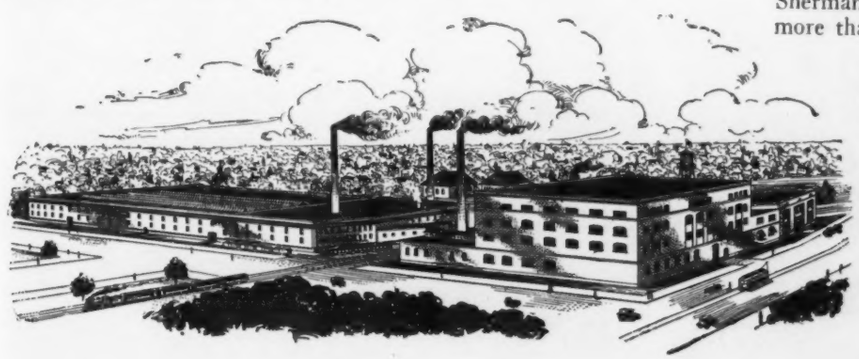


Sherman Ground Clamp

Sherman Soldering Lugs

Sherman Wire and Cable Terminals

A Huge Organization experienced in Central Station Problems has developed these Products for you . . . . . .



Sherman Ground Clamps, Soldering Lugs, Wire and Cable Terminals, and other electrical products have all been built with the care in design and workmanship which has made Sherman Products an accepted standard for more than 30 years.

Descriptive literature and free samples gladly sent on request. No obligation.

NOTE

To make fixtures a clean cut merchandising item, ready to hang, it is possible now to have the fixtures you buy factory-equipped with SHERMAN Solderless Connectors. It is the final and most advanced step in fixture development.

H. B. SHERMAN MFG. CO. BATTLE CREEK, MICH.

SHERMAN

The illustration shows one of eighteen Trenton Tower Outfits built for the Brooklyn Edison Company and specially designed for arc lamp trimming and maintenance—Tower elevation 20 feet, clearance when collapsed 11 feet.

Trenton Tower Outfit

Specially designed for Arc-Light Trimming,

Trenton Tower Outfits are a real saver on maintenance costs.

Correct Design, Rugged Construction
Good Materials Throughout
Careful Supervision

makes the Trenton Tower Outfit one that any operator has full confidence in and enables him to do better and faster work.

Send for full details.

This outfit and one man will save you money and improve your service.

J. R. McCARDELL
TRENTON, N. J.

Drop forged steel cutting head

The Bartlett Tree Trimmer

"Insulated to 105,000 Volts"

Bartlett Tree Trimmers are the choice of hundreds of leading central power stations because they are insulated for work on H.T. lines, and they have unusual capacity. The jaws are designed to shear branches of 1¼ in. thickness. The compound lever action and drop-forged steel construction result in power and long life.

The operating rod is a special Bakelite insulator, tested at 105,000 volts.

A quality tool throughout, the Bartlett Trimmer is offered as the best means of protecting your lines and workmen. Write.

BARTLETT MFG. CO.
448 E. Lafayette Ave. Detroit, Mich.

For Greater Resistance

GALVANIZE IT!

We have the largest hot dip job galvanizing plant and kettles in the United States.

We have the most modern equipment to do first class galvanizing at lowest prices.

Galvanized Products Furnished.
Prime Western Zinc Used Exclusively.
Send us your inquiries.

Joseph P. Cattie & Brothers
Gaul and Letterly Streets, Philadelphia

CANADIAN PORCELAIN CO., LTD.,
HAMILTON, ONTARIO, CANADA

Specializing

High and Low Voltage Insulators

G.P.Co

PORCELAIN INSULATORS
HIGH TENSION PIN-TYPE INSULATORS,
WET PROCESS STRAIN INSULATORS
GENERAL PORCELAIN Co.
Parkersburg, West Va.

To Serve You Best

OSHKOSH TOOLS are designed to be most practical for your pole line construction jobs. The materials used are not only the best procurable, but careful attention is given to the selection of the proper material for each tool.

Reinforcements are added at the points of stress and every tool is built to give long and efficient service.

We make a complete line of pole line construction tools. Our large stocks assure prompt shipments. Ask for catalog.

Be sure you get Oshkosh Tools to be sure of satisfaction.

Leach Company
Dept. E
Oshkosh, Wisconsin

OSHKOSH
POLE LINE
CONSTRUCTION TOOLS

Complete stocks carried by all leading jobbers throughout the country.

ILER

Live-Line Test Stick detects bad insulators

A direct reading instrument that is light, portable and safe—it is adaptable to testing any type of insulator or bushing and is also applicable for many other purposes.

For patrol work the Test Stick is equipped with earphones in addition to a meter which, on a visible scale, readily indicates a subnormal unit. The line voltage itself is utilized as an energy source, when the earphones are removed.

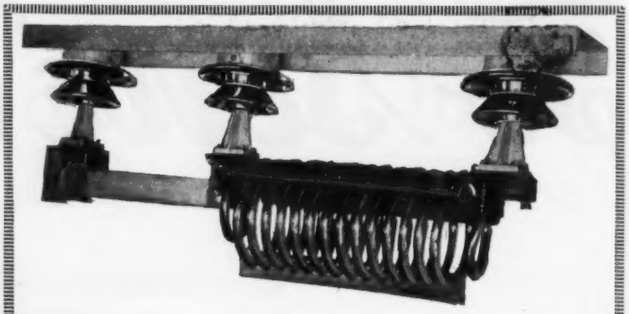
The Iler device is absolutely safe to use. It is positive in its indications. It is economical. It may be used by any lineman.

Just Out! An attractive 12-page booklet describing this device with full particulars and giving a typical test report by dependable engineers will be mailed upon request. Use the coupon.

Universal Electric Sales Corp.
30 Church St.
New York City

Gentlemen:
Please send me booklet and rates.

Name.....
Address.....
Company.....
City..... State.....
Test insulators for..... ....miles



The New

THONER & MARTENS

underslung outdoor disconnecting switch

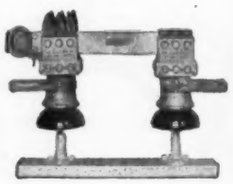
THE standard T & M underslung outdoor disconnecting switch, 800 amp., is now equipped with choke coil.

Working pressure is 22,000 volts, dry flash over is 88,000 volts and wet flash over 55,000 volts.

Other T & M features are the Bolt type lock and new sleet cover.

Write for further details

THONER & MARTENS
463 Commercial St., Boston, Mass., U. S. A.



Heavy duty Disconnect with self-aligning hinges and contacts.

Bulletin Q.

PACIFIC ELECTRIC MFG. CO.
SAN FRANCISCO — CALIFORNIA

280 Madison Ave., New York
McCormick Bldg., Chicago
Symes Bldg., Denver
135 High St., Boston
Hoge Bldg., Seattle
H. W. Hellman Bldg., Los Angeles
Pioneer Bldg., St. Paul
Interurban Bldg., Dallas
930 Wyandotte St., Kansas City, Mo.
American Trust & Savings Bldg., Birmingham

Transmission Line and Special Crossing Structures, Catenary Bridges
WRITE FOR OUR NEW DESCRIPTIVE CATALOG.
ARCHBOLD-BRADY CO.
Engineers and Contractors SYRACUSE, N. Y.

THE SEARCHLIGHT SECTION

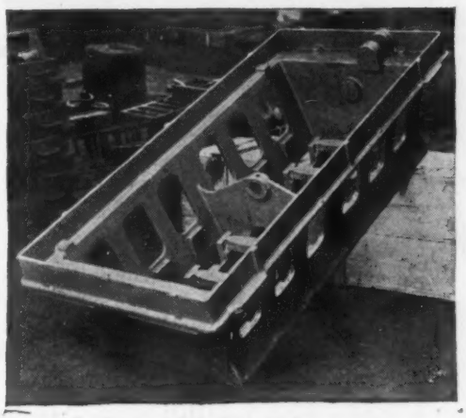
will locate the Man you want
Position you want
Equipment you want

Are you using the Searchlight?

FERRANTI

NOMAG

(Non-magnetic cast Iron)
Ferranti-Dawson Patent No. 204598.

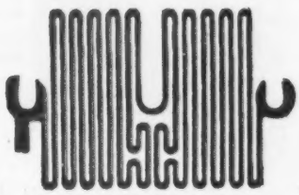


Base for a Large Oil-Switch

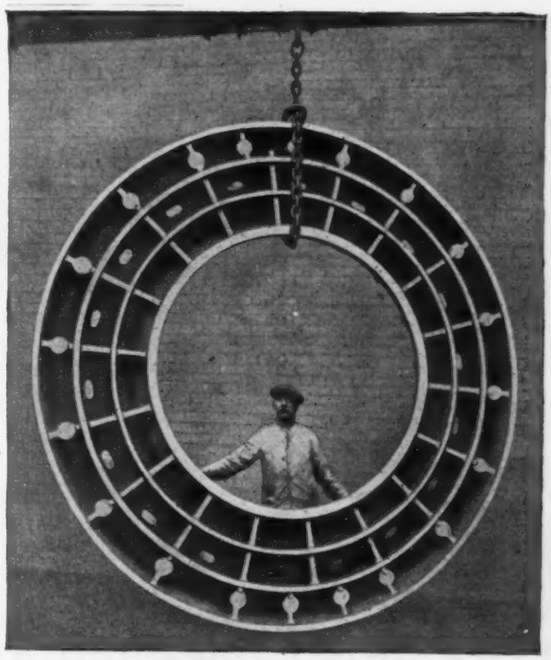
NOMAG OPENS A NEW FIELD FOR THE DESIGNER OF ELECTRICAL MACHINERY AND APPARATUS.

IT COMBINES, IN A UNIQUE WAY, HIGH RESISTANCE AND LOW PERMEABILITY, AS SHOWN BY THE FIGURES IN THE ADJACENT TABLE.

	Magnetic Permeability Maximum.	Specific Resistance Micro-ohms per cm. cube.
Ordinary Cast Iron	330.00	95.0
NOMAG . .	1.03	140.0
Brass . . .	1.00	7.5



Resistance Grid



End-ring for a Turbo-Alternator. Weight 3½ tons.

Ferranti, Ltd., Hollinwood, England

The Ferranti Meter & Transformer Manufacturing Co., Ltd. Toronto, Canada

BEST PRACTICE *in cable testing*

Lush Cable Tester **For Locating High Resistance Faults and Other Tests**
Portable Low Power Factor Watt Meter **For Measuring Dielectric Loss on Reel Lengths of Cable.**

Our Standard Line consists of microammeters, millivoltmeters, electrostatic voltmeters, magnetic flux meters, McCollum earth current meters, Kasson timers, vacuo thermocouples for use on A.C. currents of any frequency.

Low Power Factor Wattmeter

Suitable for use on power factors down to .01.

This meter can be used in the factory or field alongside of cable reel.

Lush Cable Tester

Although especially developed for location of high resistance faults without burning them down, it can be used equally as well on low faults. It will also locate breaks and measure insulation and resistance of cable.

RAWSON ELECTRICAL INSTRUMENT CO., Inc. Cambridge, Mass.

Specialists in High Sensitivity Meters

WE EXTEND the facilities of our organization to those desiring information or reports on companies with which we are identified.

Electric Bond and Share Company

[(*Incorporated in* 1905)

Paid-up Capital and Surplus, $80,000,000

71 Broadway New York

Look Into This New WALL

"Service With Safety"

DREADNAUGHT No. 41

Wind Shield Insures Efficient Operation in all Kinds of Weather.
Patented Large Non-Heating Valve Wheel
Removable Burner Block. Orifice cannot be enlarged
Patented Furnace Type Burner, Greater Heat and Continuous Operation
Easily Removable Needle Cleans Burner Orifice Every Time Valve is Opened or Closed
Large Pressed Steel Drip Cup Brazed to Supply Pipe
Clevis
Filler Plug on Top Easily Filled. No Chance for Dirt to Enter
Angle Handle Restful and Easy to Hold
Pump Has Double Check Valve, Second Held in Place by Clevis
Handle Support Does Not Extend Through Tank
Flared Base for Greater Stability
Steel Tank with Bottom and Three Connections Only Brazed. Every Tank Tested to 100 lbs. Pressure
Three Thicknesses of Steel Where Greatest Wear Takes Place

This new steel torch combines all the advantages of the time tried older Dreadnaughts with a number of improvements. Built for heavier work, to give a bigger, hotter flame. New burner cleans itself automatically. Hard brass spelter solder brazes all joints. Can be used in all kinds of weather. A better "service with safety" torch at an attractive price.

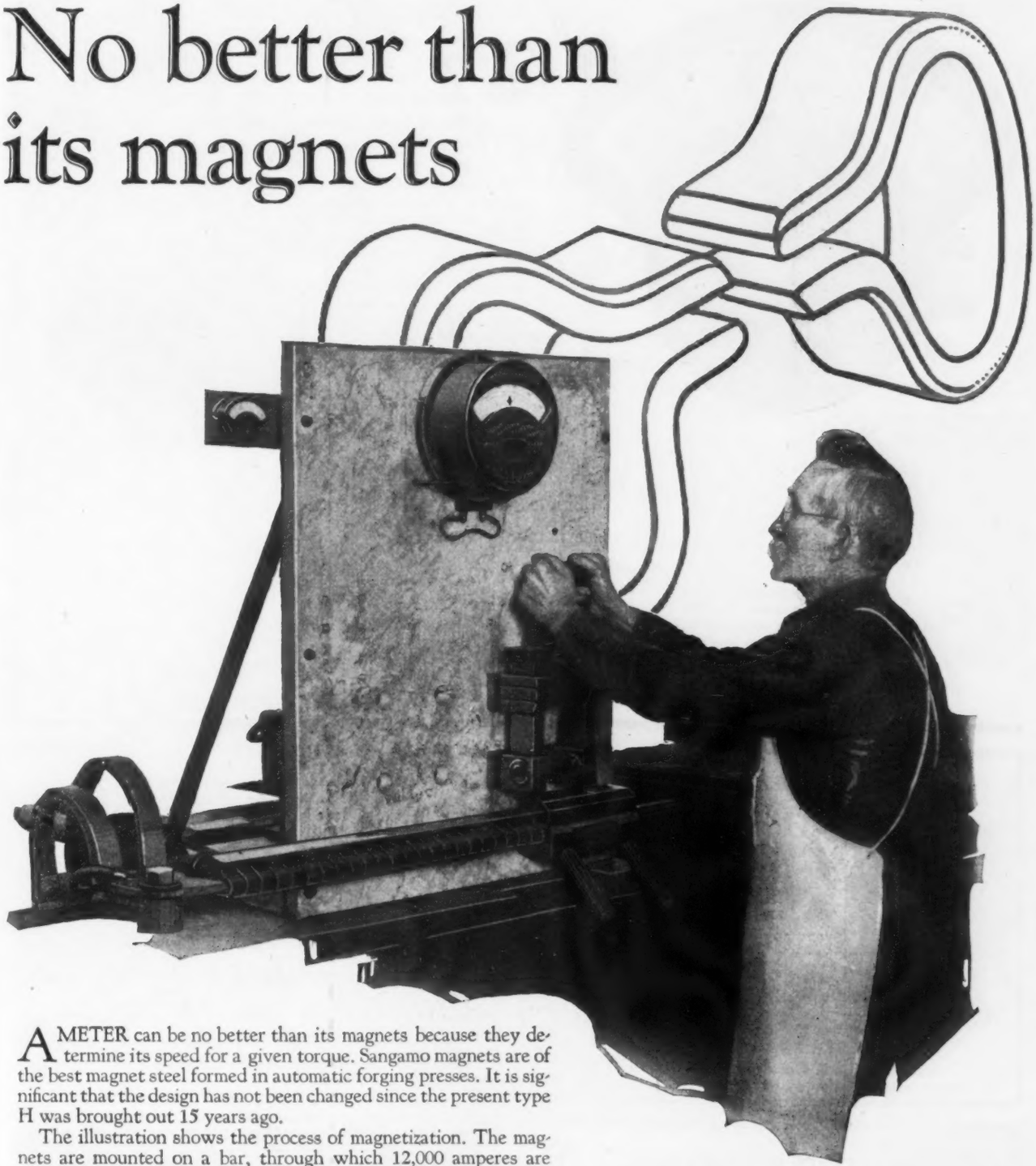
Outline your Blow Torch needs by mail. No obligation.

P. WALL MFG. SUPPLY COMPANY

3126-66 Preble Ave., N. S., Pittsburgh, Pa.

Since 1864

No better than its magnets



A METER can be no better than its magnets because they determine its speed for a given torque. Sangamo magnets are of the best magnet steel formed in automatic forging presses. It is significant that the design has not been changed since the present type H was brought out 15 years ago.

The illustration shows the process of magnetization. The magnets are mounted on a bar, through which 12,000 amperes are passed from a special storage battery, creating a tremendous flux directly through each magnet. Later these magnets are artificially aged by partially demagnetizing and then matched in pairs of equal strength. Sangamo magnets are truly permanent unless exposed to a field having greater strength than the one used in the demagnetizing process, which, however, is never encountered under operating conditions.

Both the magnet design and the artificial aging process are Sangamo developments that have proved their worth in years of service; just one example of refinements in the process of manufacture of Sangamo meters that show in after-years as well as in initial performance.

Sangamo Electric Company, *Springfield, Illinois*

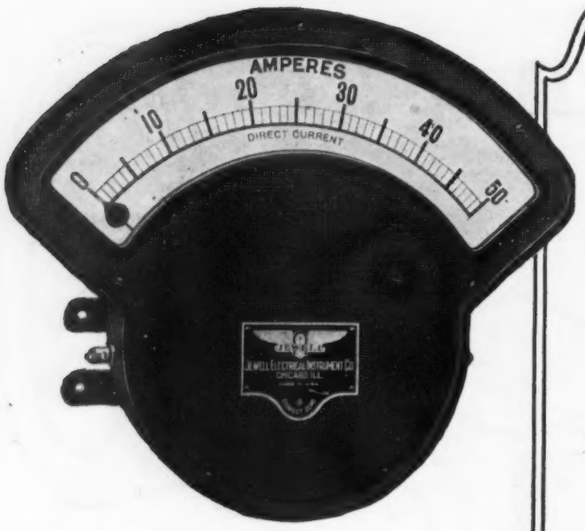
New York Boston Chicago Birmingham San Francisco Los Angeles

6531-2

SANGAMO METERS

FOR EVERY ELECTRICAL NEED

SANGAMO



Where instruments must be read from a distance as in large plating rooms, class rooms, lecture halls, boiler rooms, etc., the large illuminated dial instrument, our pattern 42, becomes of great value. The scale is 12 inches long on translucent material illuminated from rear. The instrument can be furnished with movements for D.C. as well as A.C. On special order any special movement as that for measuring power factor or frequency may be incorporated in it.

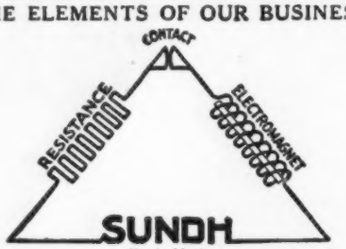
JEWELL

Best materials, most efficient tools, skilled operators, determine Jewell measuring accuracy

The control springs of electrical instruments are attached to the moving elements by soldering. This is an operation of extreme delicacy, since the hot soldering iron must not touch the pivot, nor draw the temper of the spring itself. Special flux and solder is used to get the desired results. Our operators with years of experience are highly trained and know the importance of their work. It is this exactness and careful application all the way thru that assures Jewell perfection.

Jewell Electrical Instrument Co.
1650 Walnut Street, Chicago, Illinois

THE ELEMENTS OF OUR BUSINESS



Trade Mark

Automatic Starters	Pressure Regulators
Circuit Breakers	Remote Switches
Float Switches	Speed Regulators
Hand Starters	Transfer Switches
Magnet Switches	Valve Control

WRITE FOR CATALOG

Sundh Electric Company, Newark, N. J.
Branch Offices or Sales Representatives in Principal Cities

It Never Forgets

The Hartford Time Switch never forgets to turn an electric sign or current on or off. It eliminates human forgetfulness, wasted current and inaccurate service.

Once a week's winding is all it needs.

Your jobber can tell you the details.

HARTFORD TIME SWITCH CO.

A. HALL BERRY, General Sales Agent
71 Murray St., New York, N. Y.

MOTOR STARTING SWITCHES

No. 93361

with overload protection by means of Inverse-Time Protective Plugs. For motors rated 5 Hp. and under 110, 220; 7½ Hp. 440 and 550 volts. Various phases. *Described in Circular 2.*

Are you acquainted with our Standard Unit Panelboards listed in Bulletin A.

The Trumbull Electric Mfg. Co.
Plainville, Conn.
New York Chicago San Francisco Boston Philadelphia Jacksonville

Sauter — The Swiss automatic time switch

with a record of many years' unmatched performance in all quarters of the U. S. A.

R. W. Cramer & Company, Inc.
136 Liberty Street New York, N. Y.

Only reliable products can be continuously advertised

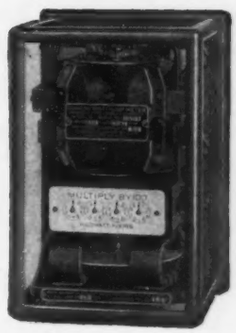
The Duncan "M2" is Standard Bearer of a Noteworthy Line

Duncan Watthour Meters

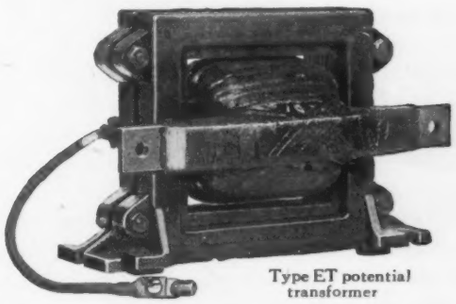
Duncan Watthour Meters, Model M2 (service type), have made the name Duncan well known and respected as indicating exceptional manufacturing excellence and operating accuracy. These characteristics are shared by the other members of the Duncan Clan— a few of which are represented here.

Duncan Alternating Current Switchboard Watthour Meters are essentially the same as the well-known Model M2 service type meter, but modified to meet the conditions of switchboard usage. Consequently they have the same high quality of construction and performance. For accessibility and ease of adjustment they are unexcelled. The Models M2S and M2PS present a neat and handsome appearance on the switchboard, the standard finish being hard rubber black and polished nickel. Other finishes can be furnished, however, if desired.

Duncan instrument transformers have unusual phase angle and ratio characteristics. In designing this line, a liberal allowance of material not only insures good characteristics but also a high safety factor.



M2A single phase meter, switchboard type



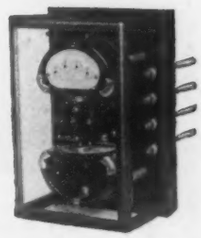
Type ET potential transformer

Duncan Type M2S Switchboard single phase meter

Duncan Model M2PA, switchboard type polyphase watthour meter. This type is finished similar to the M2P service type meter with glass cover.

DUNCAN ELECTRIC MANUFACTURING CO.
Lafayette, Indiana

DUNCAN
Watthour Meters



Duncan Model M2PS, switchboard type polyphase watthour meter. Finished in polished nickel and hard rubber, black, this type presents a beautiful appearance on the switchboard.

The Backbone of a Time Switch

The backbone of a Time Switch is the clock; and it is the quality and type of clock which is responsible for the dependable service the Time Switch gives.

Many Anderson Time Switches have been in continuous operation (except for an occasional cleaning) for over eighteen years. And, the thousands that are now in successful service all over the country, prove that an Anderson contains the most satisfactory clock that can be made for the purpose.

Anderson's Automatic Time Switches

The whole of this remarkably sturdy and accurate timepiece, as well as the switch mechanism, is made in our own plant.

The long experience, knowledge of Time Switch service and excellent clock design has established a recognition nationally, for absolute dependability of Anderson Time Switches, wherever they may be used.

Send for Bulletin No. 37 on Time Switches.

Electric Vehicle Type Receptacle 100 to 450 Amperes.

Plugs and Receptacles

These are made in many different styles for various purposes, in capacities up to 450 amperes. New and interesting applications come in almost every day, and, whether it is one or a thousand you want, our engineers are always ready to cooperate with you in the design and construction of these heavy-duty plugs and receptacles, to meet your particular conditions, exactly.

Send for Bulletin No. 38 on Plugs and Receptacles.

Albert & J. M. Anderson Manufacturing Co.

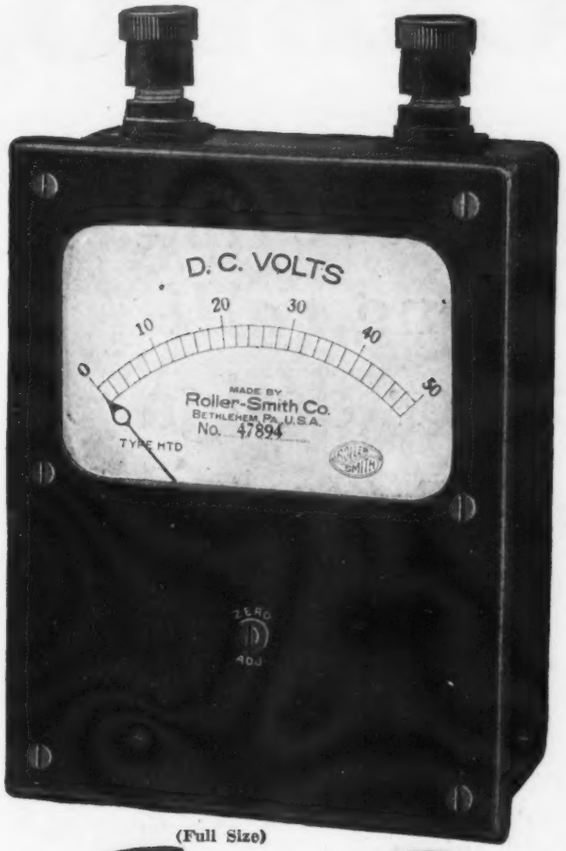
289-305 A Street, Boston, Mass.

OFFICES: New York, 135 Broadway; Chicago, 105 S. Dearborn St.; Philadelphia, Broad and Chestnut Sts.; London, 12 Moor Lane, E. C. 2.

Manufacturers of Automatic Time Switches, Charging Plugs and Receptacles, Heavy Knife Switches, Circuit Breakers, Insulators, Line Material

SOMETHING NEW

and Just What You Have Been Waiting For!



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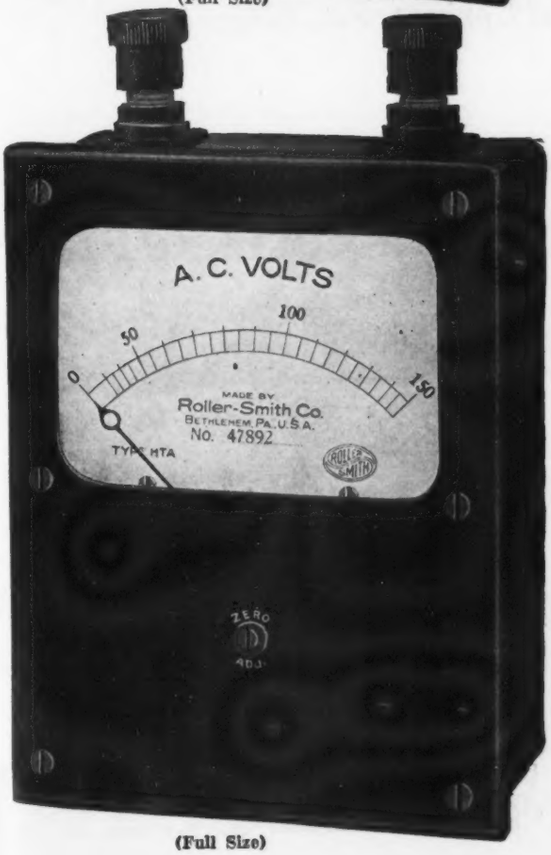


(Full Size)

Real Pocket Portable

Direct and Alternating Current

Ammeters, Voltmeters, Volt-Ammeters and Wattmeters

ROLLER-SMITH Types HTD and HTA. Small enough for your pocket, your tool kit or your traveling bag.

Compact and light enough to satisfy the most critical.

Accurate and rugged enough to suit the most exacting requirements.

A wide enough variety of ranges to cover many tests that have heretofore required large portables.

Send for *New* Bulletins D-110 and D-150.

Use the coupon.

"Over thirty years' experience is back of ROLLER-SMITH"

ROLLER-SMITH COMPANY

Electrical Measuring and Protective Apparatus

MAIN OFFICE
237 Broadway, NEW YORK

WORKS
Bethlehem, Penna.

Offices in principal cities in U. S. A. and Canada.
Representatives in Australia, Cuba and Japan.

ROLLER-SMITH COMPANY, 237 Broadway
New York City.

Gentlemen:

Please send me ROLLER-SMITH Bulletins Nos. D-110 and D-150.

Name .....

Company .....

Address..... *State*.....

A Forecast or

As to the future, I believe that there will be, before long, ***radical changes*** in boiler design and installations, for central station and large industrial plants—

**From the President's address at the American Boiler Manufacturers' Ass'n. Convention, Hot Springs, Va., May 31—June 2, 1926.*

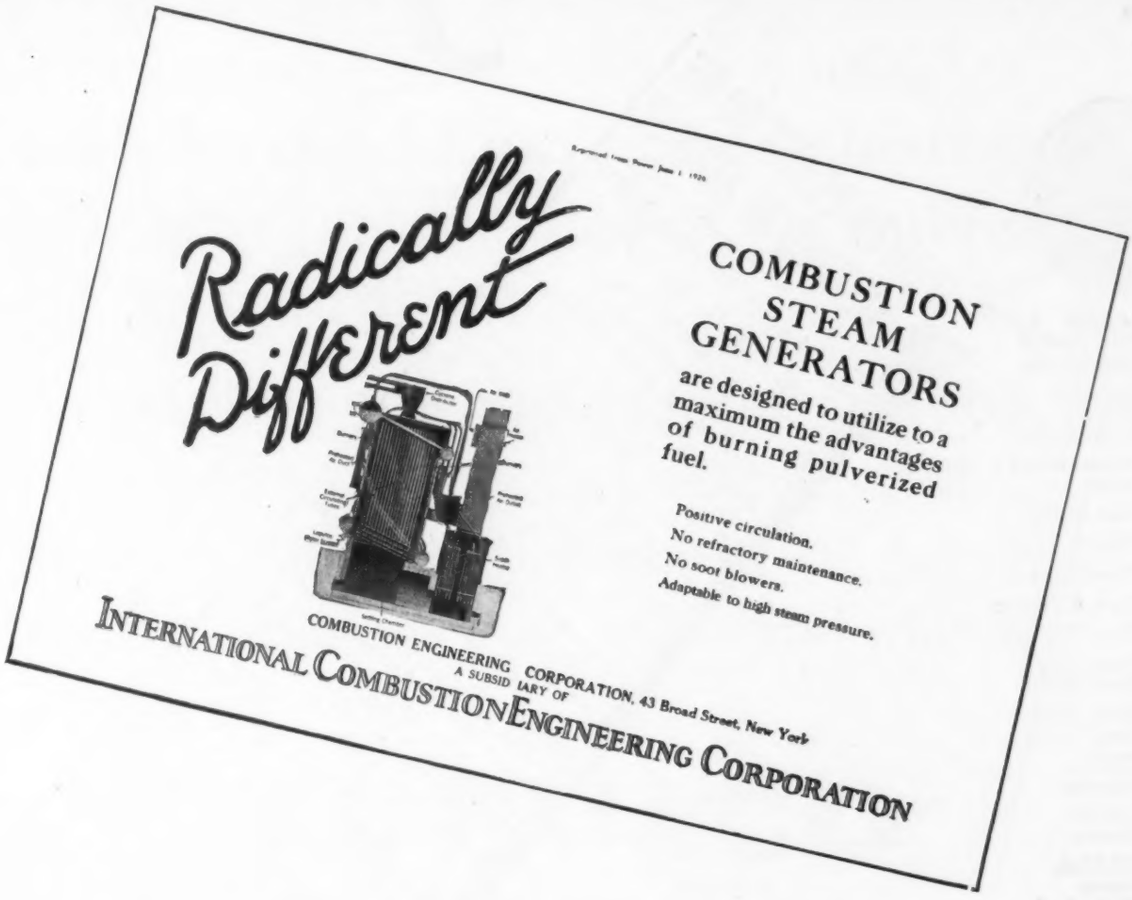
Combustion pioneered pulverized fuel—

Lopulco Systems

COMBUSTION ENGINEERING
A SUBSID

INTERNATIONAL COMBUSTION

ran Admission


Radically Different
COMBUSTION STEAM GENERATORS
are designed to utilize to a maximum the advantages of burning pulverized fuel.
Positive circulation.
No refractory maintenance.
No soot blowers.
Adaptable to high steam pressure.
COMBUSTION ENGINEERING CORPORATION, 43 Broad Street, New York
A SUBSIDIARY OF
INTERNATIONAL COMBUSTION ENGINEERING CORPORATION

Now pioneering more efficient steam generation—

Combustion Steam Generators

CORPORATION, 43 Broad Street, New York
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Avon joins t

INTERNATIONAL COMBUSTION ENGINEERING CORPORATION

- Lopulco Pulverized Fuel System ✓
- Frederick Multiple Retort Stoker
- Self-contained Stoker
- Coxe Stoker
- Type E Stoker
- Type D Stoker
- Type K Stoker
- Type H Stoker
- Green Natural Draft Stoker
- Green Forced Draft Stoker
- C-E Fin Furnaces
- C-E Air Heaters
- C-E Unit System (Pulverized Fuel)
- Grieve Grates
- Combusco Ash Conveyors
- Quinn Oil Burning Equipment
- Combustion Steam Generator
- Ladd Water Tube Boilers

POWER PLANT TO BE OPENED IN AUGUST

Unit of North American System at Avon, O., To Be Put in Operation.

Cleveland, July 29.—The latest of the North American System's great power plants will be placed in operation at Avon, Ohio, on Wednesday, Aug. 4, when the first unit of the 90,000 horse-power initial capacity of the Avon station of the Cleveland Electric Illuminating Co., a North American subsidiary, will be dedicated, with Charles F. Brush, the 77-year-old inventor of the electric arc lamp, opening the throttle of the generator. A large gathering of men notable in engineering and in public life will be present at the ceremonies.

The Avon plant, which will eventually have a capacity of 400,000 horse-power, representing an investment of over $30,000,000, is located 23 miles west of Cleveland on Lake Erie. The addition of its initial capacity will raise that of the Illuminating Co. to more than 500,000 horse-power, and eventually to 800,000. While high tension connections have been made to carry power to distant parts of the state, it is expected that most of the company's eventual great capacity will be taken locally through the intensive development of Cleveland's iron, steel and other industries. For this reason the opening of the Avon station is regarded as one of the most important industrial developments in the Great Lakes region. Avon represents the most advanced engineering practice in the production of electricity by coal and steam. Pulverized coal will be used exclusively, and it is confidently expected by the North American officials that the boiler efficiency will equal or exceed that of the system's Lake Shore station, whose pulverized fuel units for two years has maintained the highest operating efficiency of any boiler plant in the world.

New York Commercial
July 29, 1926

Combustion

43 Broad St., New York

Corpor

A SUBSIDIARY OF INTERNATIONAL

the ranks

The opening of the Avon Station of the Cleveland Electric Illuminating Co. is of great interest to public utility companies.

Avon, like the Lake Shore Station operated by the same Company, adds another link to the chain of large central stations and industrial plants equipped with

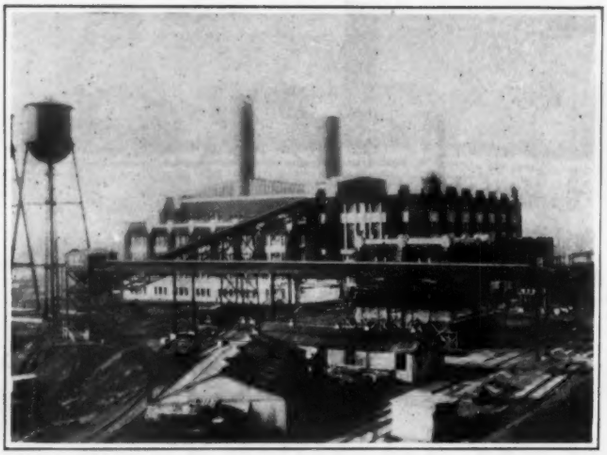
LOPULCO
Pulverized Fuel
SYSTEM

Where investigation is thorough
LOPULCO *wins*

Engineering

ration *Offices throughout the World*

NAL COMBUSTION ENGINEERING CORPORATION



Twin Branch Plant, The Indiana and Michigan Electric Co., Mishawaka, Ind. Three No. 42 and three No. 66 American Coal Crushers are in use here.

They had good reasons for
specifying
AMERICAN
Rolling Ring Type
COAL CRUSHERS

When a power company specifies a particular type of equipment for a power station, it is usually because information available is favorable to that equipment. Experience with American Coal Crushers has convinced many progressive power companies that these machines are unexcelled for preparation of coal for stokers, in performance, and operating economy.

The unique design of the American Ring Crusher results in an exceptionally uniform product, with a very low percentage of fines, and their construction gives them unusually long life.

They crush r. o. m. coal, all costs included, for less than 2 cents per ton.

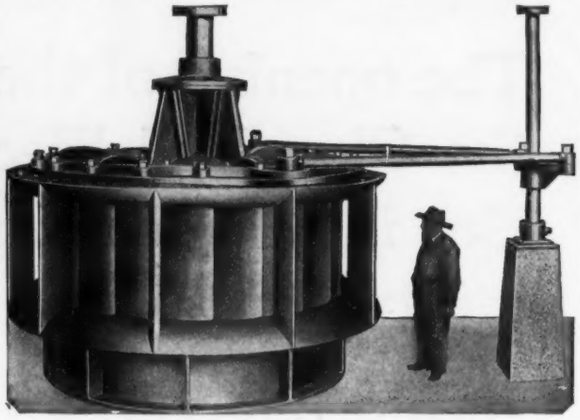
AMERICAN PULVERIZER CO.
18th and Austin Sts., St. Louis, Mo.

Write for our catalog
(and ask a user too!)

LEFFEL

TURBINE WATER WHEELS

High Speeds, High Powers, High Efficiencies



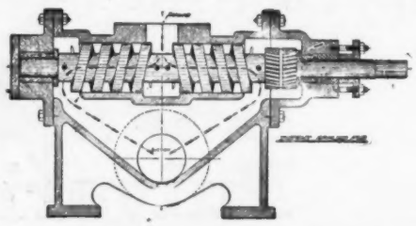
Vertical High Speed Heavy Duty Turbine

We furnish many large vertical and horizontal turbines, developing power, speeds and high efficiencies to meet requirements. Turbines and results fully guaranteed.

The James Leffel & Co., Springfield, Ohio

BRANCH OFFICES:

NEW YORK, N. Y. ..... 39 Cortlandt St.
BOSTON, MASS. ..... 80 Boylston St.
ATLANTA, GA. ..... 4th Nat'l Bank Bldg.
MINNEAPOLIS, MINN ..... Plymouth Building
LANCASTER, PA. ..... Woolworth Bldg.
PETERBOROUGH, ONT., CANADA ..... William Hamilton, Ltd.



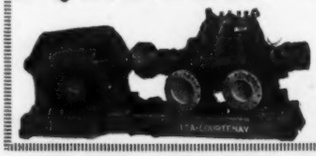
Quimby Screw Pump

SPECIAL PUMPS

For Fuel Oil Service, Hydraulic Turbine Governors, Lubricating Oil, Calcium Brine, and Water Systems. Handles any fluid or semi-fluid that will flow. Capacities up to 4200 G.P.M. We also build horizontal and vertical centrifugal pumps up to 500 G.P.M.

WILLIAM E. QUIMBY, Inc., Newark, N. J.

LECOURTENAY



CENTRIFUGAL PUMPS

LECOURTENAY CO.
26 MAINE STREET
NEWARK, NEW JERSEY

Ridgway

When Considering
Turbines, Engines, Generators
Motor-generators, Rotary Converters
Synchronous Motors, or Turbo-Blowers
Refer to our Family Group
First issue of each month
Ridgway Dynamo & Engine Co.
Ridgway, Pa.

Make YOUR Pulverizer Operation SAFE and CERTAIN with a TERRY

UNIT pulverizers demand the maximum dependability in prime movers. That is one of the reasons why Terry single stage turbines are driving so many pulverizers today.

They have proved most satisfactory operating Aero, Combustion, Erie City, Riley and Strong-Scott pulverizers.

In the Terry, steam acts directly on a single one-piece, practically indestructible wheel — the simplest method that insures greatest reliability of operation.

> ***Where a Minute Counts!***
>
> **"The supply of pulverized fuel cannot be interrupted if the load is to be carried. One minute would seem to be the maximum allowable outage."**
>
> **N. E. L. A. Report**

Rugged construction throughout gives great durability, while the flexibility of the Terry design makes it possible to meet new or unusual operating conditions such as increased speed, changed steam pressure, etc.

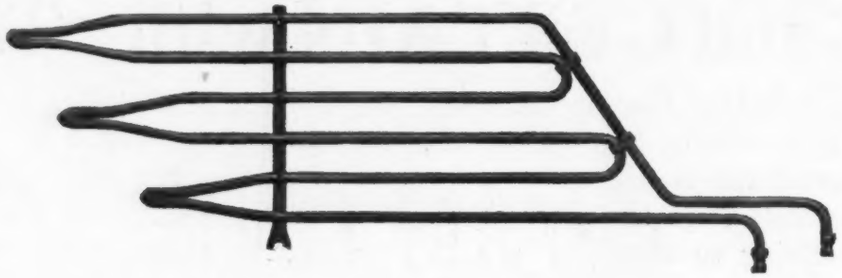
For your next pulverizer drive, specify Terry and prevent shutdowns, trouble and repairs.

THE TERRY STEAM TURBINE COMPANY
Terry Square, Hartford, Conn.

50 H.P. Terry Turbo Gear Unit Driving Aero Pulverizer

T-972

THE TERRY TURBINE



Construction

The unusual success of the Elesco superheater in central station and industrial services is due largely to the return bend and joint construction. Elesco superheater units, in which these features are combined, meet all requirements of space and boiler arrangements with the least number of steam joints and minimum amount of obstruction to the gasses

The most discriminating buyers of power generating equipment for public utility and industrial power stations are satisfied users of Elesco superheaters. These customers, among others, include:

New York Edison Co.
Henry L. Doherty & Co.
Commonwealth Edison Co. of Chicago
W. S. Barstow Assn.
Thomas E. Murray, Inc.
Sargent & Lundy
Stone & Webster
U. S. Steel Corp.
Bethlehem Steel Co.
Colorado Fuel & Iron Co.
Ford Motor Co.
E. I. Dupont de Nemours
Standard Oil Co.
Vacuum Oil Co.
New York Central R.R.

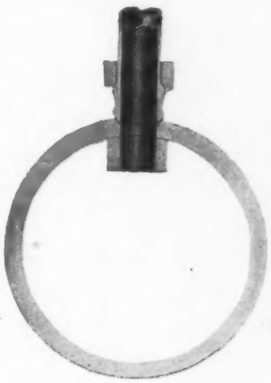
These Are Elements of Success

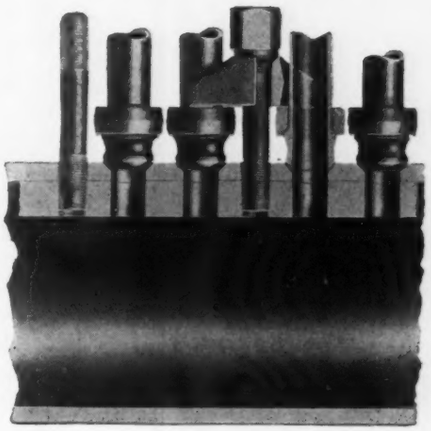
The Forged Return Bend

A method of joining tubing to permit lengths, arrangements, heating surfaces and uniform steam flow areas most advantageous to the design of superheater units.

The Ball Joint

A metal-to-metal contact — eliminates handholes and reduces the number of joints — flexible, remains tight under most severe operating conditions, easy to adjust and maintain.





Millions of these forgings and ball joints are in daily use under the most severe operating conditions.

THE SUPERHEATER COMPANY

17 East 42nd Street, NEW YORK

Peoples Gas Bldg., CHICAGO — ELESCO — Union Trust Bldg., PITTSBURGH

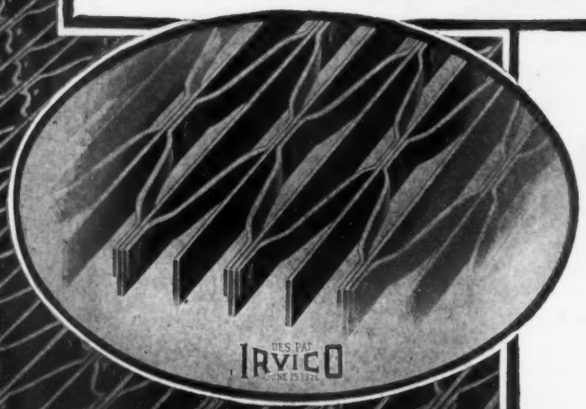
Represented in

Atlanta	Kansas City	Charlotte	San Francisco
Houston	Boston	New Orleans	Denver
Birmingham	Memphis	Salt Lake City	St. Paul

Canada: The Superheater Company Limited, Montreal

OPEN STEEL IRVING FLOORING

TRADE MARK SUBWAY REGISTERED



A Time-Tested Material for Construction

Novelty, usually combined with a low price, may gain for a new product a temporary vogue, at the hands of those who fail to look for fundamental, lasting values. But demonstrated worth alone can create an ever-increasing demand, and maintain it over a long period of years.

The **Irving Flooring** in use today, if gathered together, would cover an area a mile long and over a thousand feet wide. And each year's sales, larger than the last, add hundreds of thousands of square feet to this total.

The new **"Irvico"** type, here pictured, embodies the lessons learned in producing this immense footage over a period of 14 years. It is new only in the shape of its mesh. It is 14 years old in the mastery of floor-craft which it represents.

Let us send Bulletin H4.

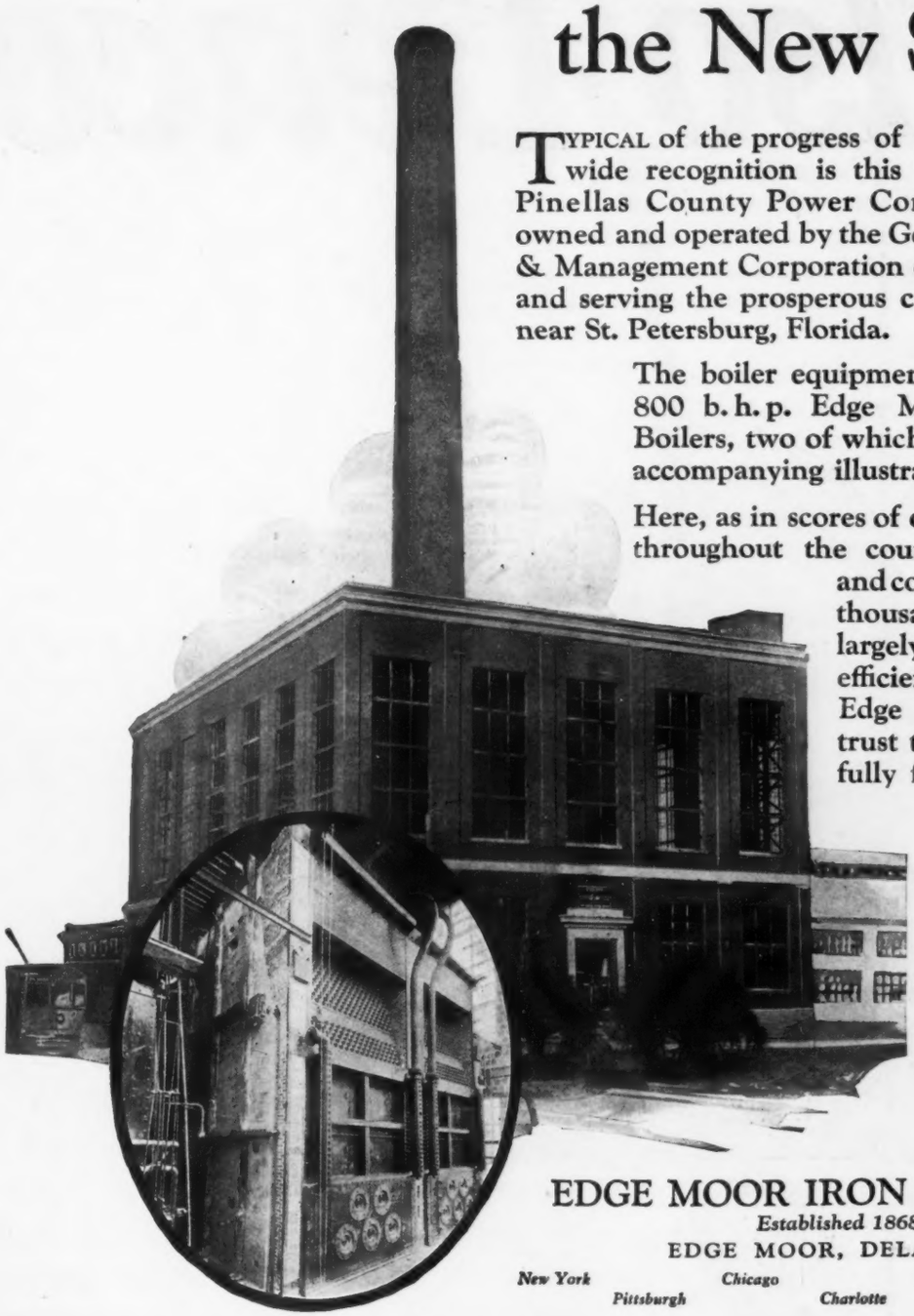
IRVING IRON WORKS CO.
LONG ISLAND CITY, N.Y. U.S.A.
Established 1902

A Landmark of the New South

TYPICAL of the progress of the South and its wide recognition is this new plant of the Pinellas County Power Company, designed, owned and operated by the General Engineering & Management Corporation of New York City, and serving the prosperous community in and near St. Petersburg, Florida.

The boiler equipment consists of four 800 b. h. p. Edge Moor Cross-Drum Boilers, two of which are shown in the accompanying illustration.

Here, as in scores of other communities throughout the country, the comfort and convenience of some thousands of people are largely dependent on the efficient performance of Edge Moor Boilers—a trust that is being faithfully fulfilled.



EDGE MOOR IRON COMPANY

Established 1868

EDGE MOOR, DELAWARE

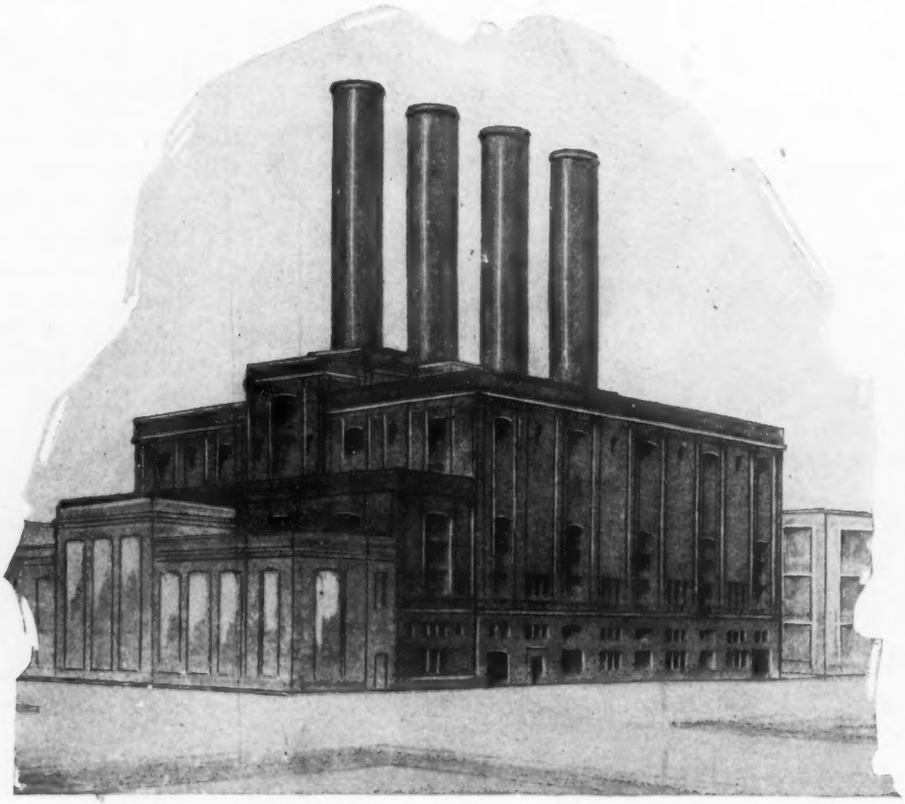
New York *Chicago* *St. Paul* *Boston*

Pittsburgh *Charlotte* *Los Angeles*

EDGE MOOR Water Tube BOILERS

FOR INCREASED FUEL ECONOMY

Also Beacons



The Taylor Stoker

Gets more heat from a pound of coal than any other Combustion System

Street!

The Detroit Edison Company has been noted for operating one of the most efficient and progressive steam heating systems in the world. In line with this fact, their new Beacon Street Heating Station is an outstanding example of the latest combustion engineering practice.

The initial installation is two 4150 h.p. units—the largest boilers thus far built.

Each of these boilers will be fired by two 14-retort Taylor Stokers.

The choice of Taylor Stokers for this great heating station came as the result of the experience of The Detroit Edison Company with the Taylor Stoker in its other heating plants in downtown Detroit and in its large Taylor-fired generating stations.

Marysville

Edgar

Richmond

Fisher Body

Riverside

Kearny

Central Illinois Light

Chester

Dayton Power and Light

Zilwaukee

Dodge Brothers

Haverhill Electric

Battle Creek

Fifty-Ninth Street

Hell Gate

Beacon Street Heating Plant

Saxton

Indiana Service

Taylor Stoker literature will be gladly supplied to anyone interested in power plant design or operation.

AMERICAN ENGINEERING COMPANY
PHILADELPHIA

Canadian Sales and Service by Affiliated Engineering Companies, Ltd.
Head Office: Southam Bldg., Montreal, Que.

De Laval Feed Pumps

for High Pressure Boilers

are distinguished by:—

Three motor-driven six-stage boiler feed pumps, 300 gals. per min. each against 450 lbs. at 1750 RPM.

CONSERVATIVE SPEEDS AND LOW PRESSURE PER STAGE, giving longer life and less tendency to cavitation and vibration.

HIGH EFFICIENCY AT FRACTIONAL LOADS.

SOLID ONE PIECE DIAPHRAGMS, to eliminate leakage and blowing out of packing between stages.

SINGLE SUCTION IMPELLERS, which require only one set of wearing rings per impeller instead of two.

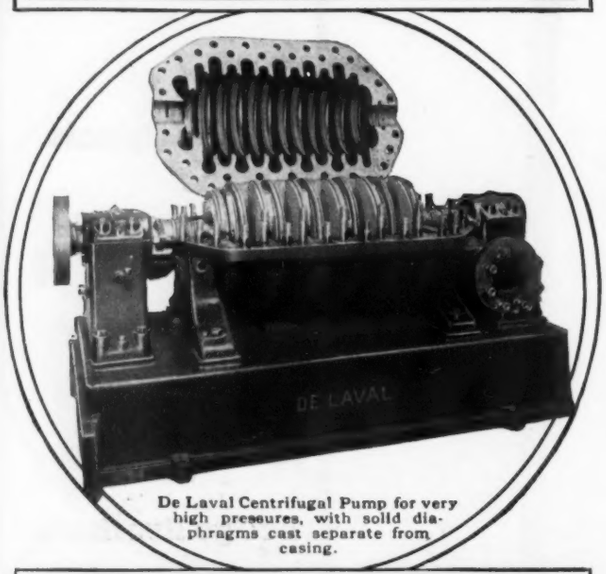
LABYRINTH WEARING RINGS, permitting operating clearances from three to four times greater than with flat rings for the same leakage.

SHAFT PACKINGS subject to suction pressure only.

HYDRAULIC BALANCING DEVICE, which divides pressure drop equally and reduces erosion.

DE LAVAL STEAM TURBINE DRIVEN BOILER FEED PUMPS are designed, assembled, inspected and tested in one shop and guaranteed by one concern. The turbine has been specially designed for high pressure, high temperature steam.

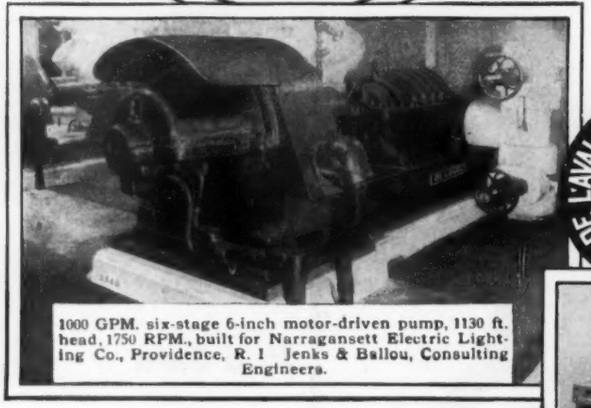
POWER LIMITING CHARACTERISTIC and low starting torque of De Laval pumps render oversize electric motors unnecessary and favor high motor efficiency and power factor.



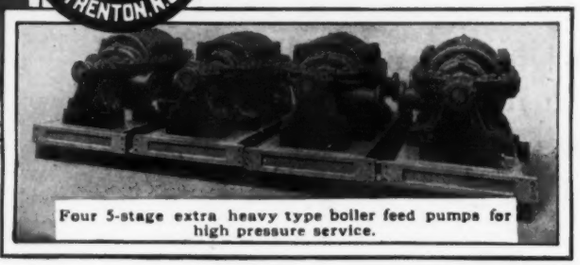
De Laval Centrifugal Pump for very high pressures, with solid diaphragms cast separate from casing.

All De Laval apparatus is built on an interchangeable basis.

Ask for Catalog B 43.



1000 GPM. six-stage 6-inch motor-driven pump, 1130 ft. head, 1750 RPM., built for Narragansett Electric Lighting Co., Providence, R. I. Jenks & Ballou, Consulting Engineers.



Four 5-stage extra heavy type boiler feed pumps for high pressure service.

De Laval Steam Turbine Co.

LOCAL OFFICES

Atlanta, Boston, Charlotte, Chicago, Cleveland, Dallas, Denver, Duluth, Helena, Houston, Indianapolis, Kansas City, Los Angeles, Montreal, New York, New Orleans, Philadelphia, Pittsburgh, Portland, Ore., St. Paul, Salt Lake City, San Francisco, Seattle, Spokane, Toronto, Vancouver

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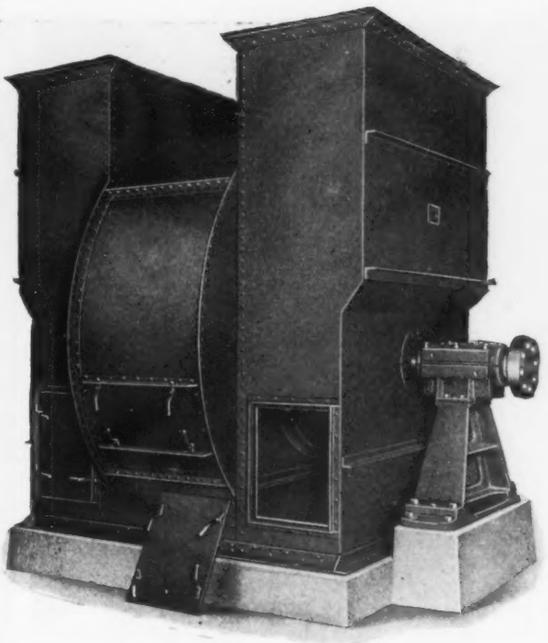
570

Manufacturers of Steam Turbines, Centrifugal Pumps, Centrifugal Blowers and Compressors, Double Helical Speed Reducing Gears, Worm Gears, Hydraulic Turbines, Flexible Couplings and Special Centrifugal Machinery



What WE mean by Efficiency—

Buffalo Mechanical Draft Apparatus has been and is being installed in a large number of the great modern power stations which are dedicated to Efficiency.

The utilization of cheaper grades of fuel, the increased size of the units, the installation of boilers to operate continuously between three and four hundred per cent of ratings, the use of superheaters, air preheaters and economizers have created entirely new mechanical draft problems.

Buffalo equipment for this work is long lived, due to its construction, while its design gives an operating efficiency *under all loads* that makes it the logical choice of the Consulting Engineer.

These Plants Use "Buffalo" Fans—

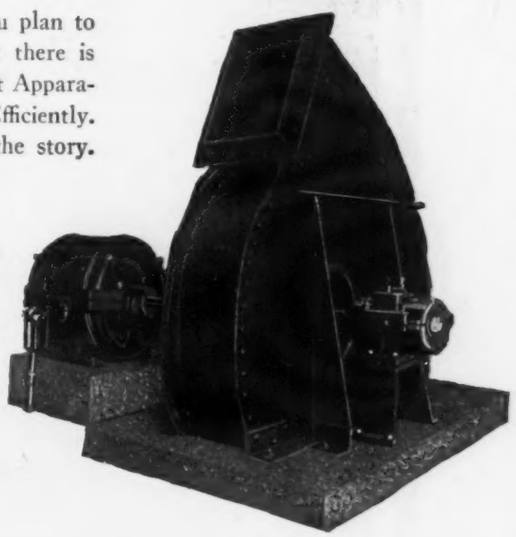
Philo Station, Ohio Power Co.; Columbia Power Station, Columbia Power Co.; Hell Gate Station, United Electric Light & Power Co.; Avon Station, Cleveland Electric Illuminating Co.; Hudson Ave. Station, Brooklyn Edison Co.; Calumet Station, Commonwealth Edison Co.; Crawford Ave. Station, Commonwealth Edison Co.; Northern States Power Co., St. Paul, Minn.; San Angelo Power Station, West Texas Utilities Co.; Illinois Northern Utilities Co.

For Continuous EFFICIENCY

No matter what fuel you plan to use in your power plant there is Buffalo Mechanical Draft Apparatus to handle your needs Efficiently. Our Catalog 730 tells the story.

A Buffalo Single Width Double Inlet Duplex Conoidal Induced Draft Fan is shown at the upper left.

At the Right The Buffalo Type "R" Steel Plate Pressure Blower for use with pulverized coal and oil fires.



BUFFALO FORGE COMPANY

Broadway Buffalo, New York

In Canada, Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

"Buffalo"

Mechanical Draft Apparatus

An artist's conception of an 8,000,000 kw. Central Station of the future.

The aggregate capacity of the Cameron Class HMT boiler feed pumps now in Central Stations in America would be sufficient for such a plant.

Yesterday's visions are to-day's realities and to-morrow's history

WE need our visionaries: Their dreams point the way to progress. We need our producers: They materialize those dreams. We need our histories: They guide in building for the present and for the future.

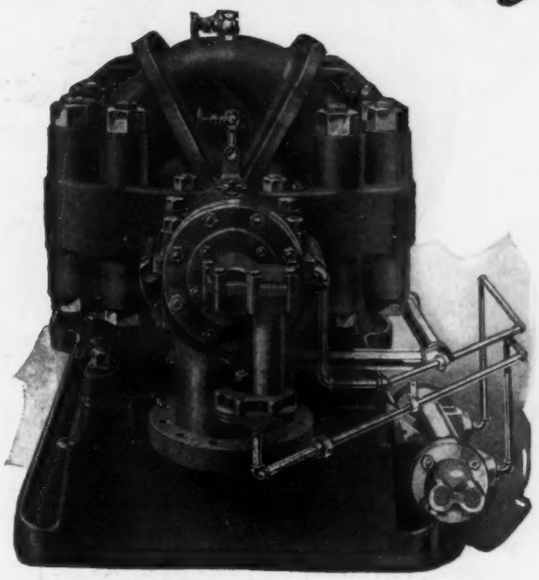
The vaults of Cameron contain a splendid history of successful pump building achievements during the past sixty years. This history is made up of thousands of designs and patents. It includes test and performance records of Cameron Pumps on every conceivable fluid-handling service. This history is a composite of the creations of some of the best engineering minds of three generations. It is the foundation for Cameron's present success and the promise of future achievements.

There are a great many meritorious installations of Cameron Pumps in modern central stations, power plants, paper mills, sugar mills, and factories of all kinds. These installations are concrete evidence that Cameron engineers have produced pumps to meet adequately all present-day requirements.

Unusual conditions arise. Central stations operate at ever-increasing boiler pressures; mine drainage is handled in one lift; sugar mills and paper mills must speed up the handling of their viscous fluids; condensate must be taken care of more efficiently. Whenever any condition of this nature has arisen, there has been a Cameron Pump ready for the task. Time after time, Cameron designers (call them "Hydraulic Visionaries," if you will) have solved the problem in the laboratory before the problem had even arisen in actual practice.

Cameron has won the utmost confidence of its customers. To win this confidence, Cameron business must have been conducted under the guidance of a sound sales and service policy.

Let Cameron engineers help you with your pumping problems. Their experience and their ability are at your disposal.



End view of Cameron Class HMT Boiler Feed Pump. This shows the force-feed-lubricated Kingsbury Thrust Bearing. Note the massive construction.

Ingersoll-Rand and Cameron Equipment for the Central Stations:

Surface Condensers
Boiler Feed Pumps
Circulating Pumps
Condensate Pumps
Service Pumps
Vacuum Pumps
Pneumatic Tools
Paving Breakers
Air Compressors

INGERSOLL-RAND COMPANY—11 BROADWAY, NEW YORK CITY

Offices in principal cities the world over

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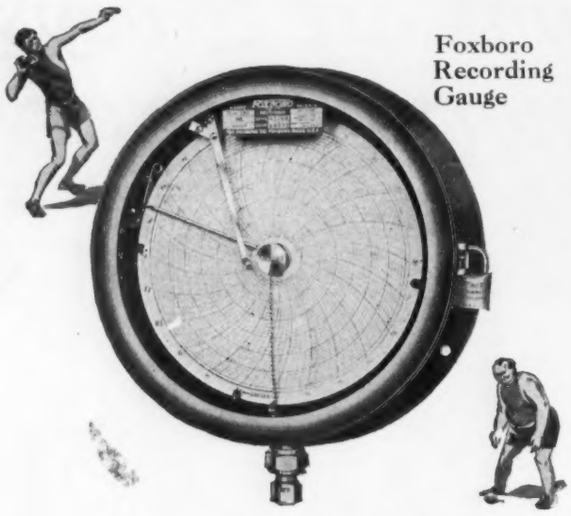


Foxboro Recording Gauge

Strength vs. Weight

A FAT, heavy man can't compete with a trained athlete. Weight doesn't mean strength in athletics any more than it does in an actuating movement, the part that drives the pen arm of a recording instrument.

The strength of an actuating movement is not produced by great weight and broad bearing surfaces, which often mean excess friction and lost motion. And much talk about weight distracts attention from the one important consideration—**ultimate power delivered to the pen arm.**

The actuating movements of Foxboro Recorders have strength with the minimum weight and number of moving parts. They are as lithe and sinuous as a greyhound, and as responsive to changes as the needle of a compass. All the power of the movement is delivered to the pen arm; nothing is lost.

A Foxboro movement will not lose its accuracy because there is no excess friction, lost motion, inertia or momentum.

All Foxboro Instruments are **guaranteed permanent in calibration and are accurate to within less than 1 per cent of total scale range.** They give you the utmost in instrument accuracy and dependability.

THE FOXBORO CO., Inc.

Neponset Avenue, Foxboro, Mass., U. S. A.

New York Chicago Boston Philadelphia Pittsburgh
Cleveland Rochester Atlanta Tulsa
Los Angeles San Francisco Portland, Ore.

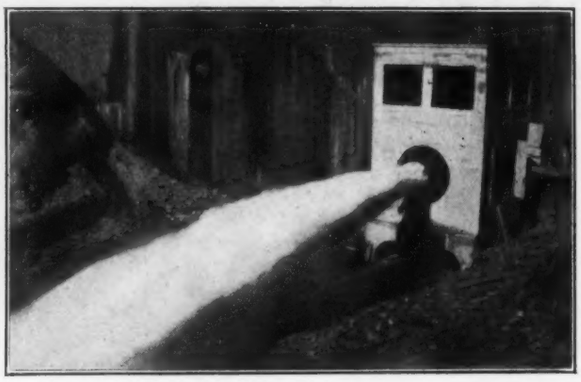
Peacock Brothers, Limited, 1605 Delorimier Avenue, Montreal, Canada
Sole British Representatives: Walker-Crosweller & Co., 58 Queen Elizabeth Street, London, S. E.

FOXBORO

REG. U. S. PAT. OFF.

THE COMPASS OF INDUSTRY

PELTON



This 62-in. free discharge regulator of the Larner-Johnson type is installed in the base of Cushman Dam, a project of the City of Tacoma, being designed to discharge 1850 c.f.s. under 200-ft. static head. The illustration shows the valve partially opened, discharging approximately 900 c.f.s. under 175-ft. head. A 90-in. Pelton electric motor operated butterfly valve is installed ahead of the discharge regulator to permit unwatering of the latter.

THE PELTON WATER WHEEL COMPANY

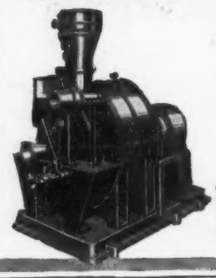
Hydraulic Engineers

2983 Nineteenth St., San Francisco **100 Broadway, New York**

Associated Companies: Wm. Cramp & Sons Ship & Engine Bldg. Co., Philadelphia; Dominion Eng. Work, Montreal; Sociedade Anonyma Hilpert, Rio de Janeiro.

PELTON

The **SIMPLEX UNIT SYSTEM**



UNIT PULVERIZER
FURNACE
BURNERS PIPING

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FURNACE ENGINEERING CO. INC.
5 BEEKMAN ST. NEW YORK, N.Y.

LOMBARD
WATER WHEEL
GOVERNORS

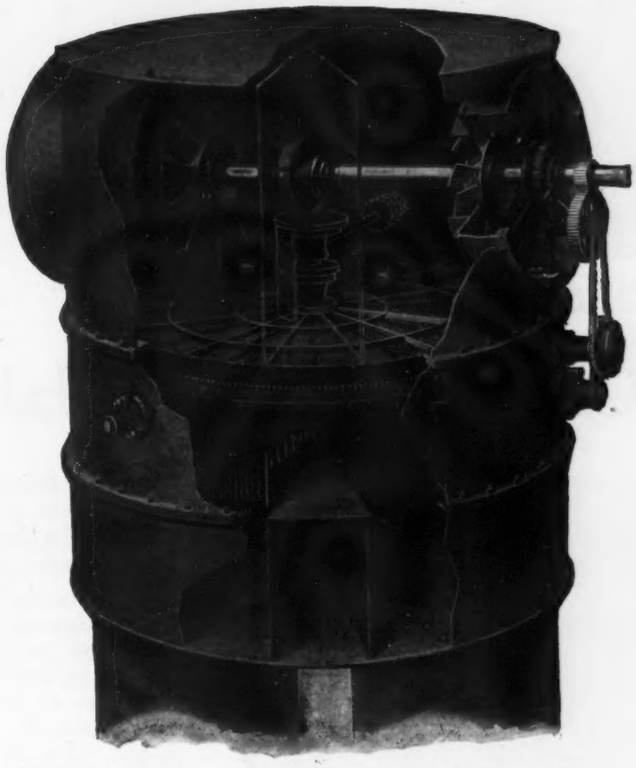
Powerful, quick-acting oil-pressure governors in sizes and types for any application or special condition. For many years, the name LOMBARD has stood for *reliable service* and *closest regulation obtainable.*

THE
LOMBARD
GOVERNOR CO.
ASHLAND, MASS.

Ljungström AIR PREHEATER

SUPERHEATED AIR

150,000 Boiler Horsepower Installed



Made in Standard Sizes

Up To 5000 Boiler H. P.

Permanent Efficiency

The efficiency of the Ljungström Air Preheater will be the same 10 years hence as at the time of installation. The ***regenerative counterflow*** principle used eliminates all chances of leaky plates or tubes.

Heat storage in the elements versus heat transfer ***through*** metal, once and for all time eliminates decrease of efficiency due to soot deposits.

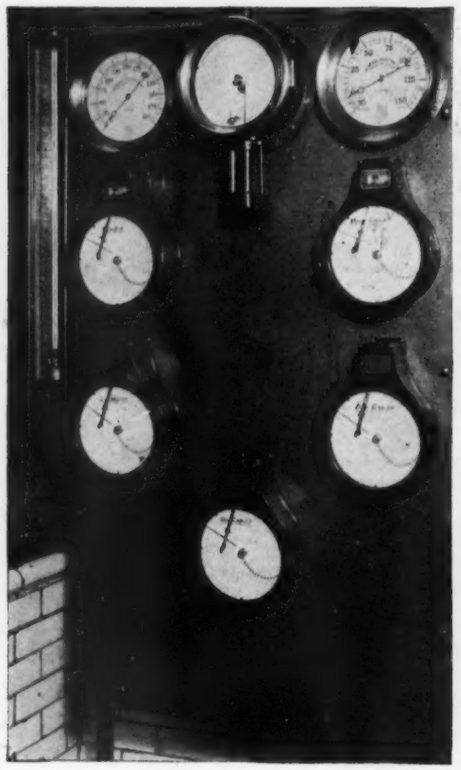
The Ljungström method—which guarantees the same savings year after year,—merits your most serious consideration.

Let our engineers discuss this important problem with you.

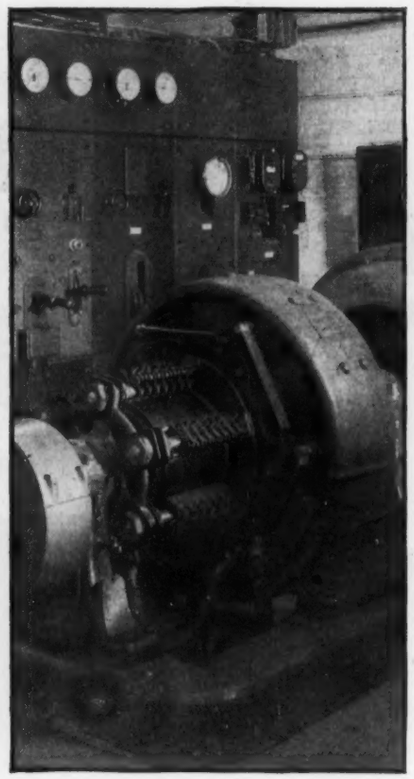
THE AIR PREHEATER CORPORATION

25 Broadway, New York

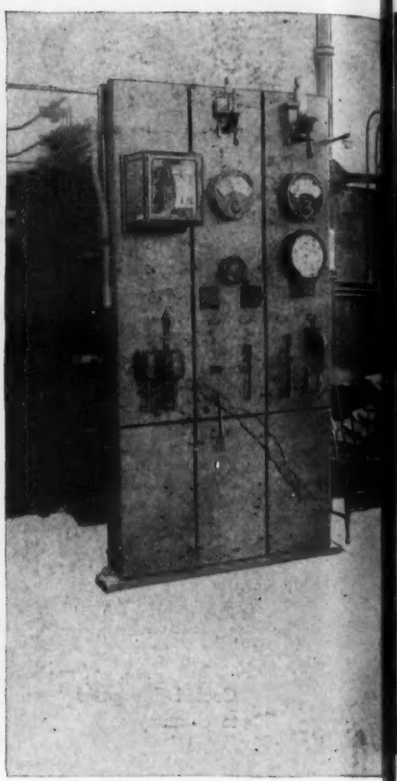
Canadian Licensees—Lammers & Maase, Ltd., 240 Craig St., West, Montreal



Typical board with Bristol's at the Virginia Railway & Power Co., Norfolk, Va.

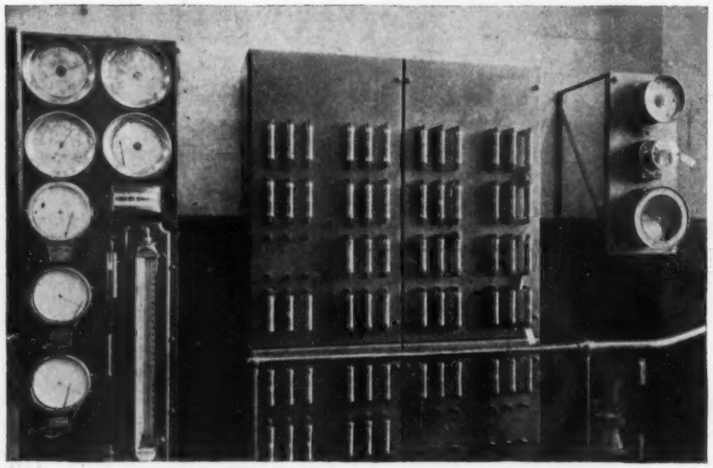


A Bristol's recording voltmeter in a large railway and power company's substation.



A Bristol's recording voltmeter on an automatic reclosing circuit breaker panel.

BRISTOL'S—the dependable recordingins

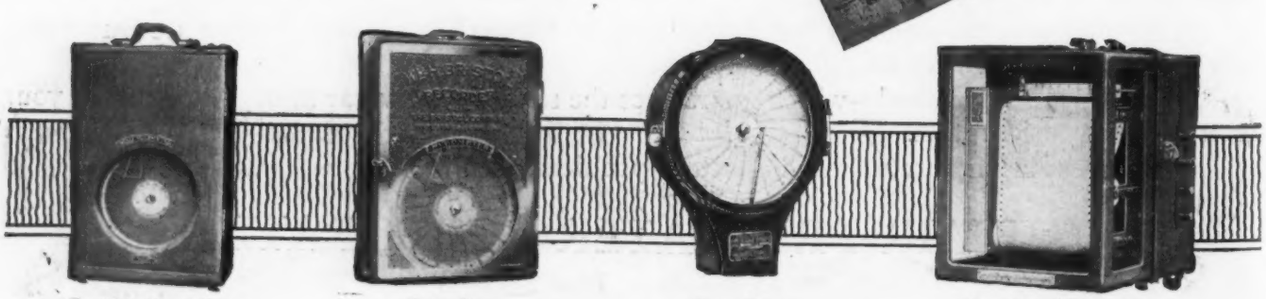


Pittock Station Board—Northwest Electric Co., Portland, Ore.

It makes no difference what kind of new construction; steam plants—hydro-electric or industrial—Bristol's Recording Instruments are in demand because of past performance records.

Since the valuable information obtained from the chart records made by BRISTOL'S Instruments has become more and more recognized as absolutely imperative to efficient plant operation, the number of BRISTOL'S Instruments has greatly increased.

Here is a new booklet on Bristol's recording voltmeters just off the press. Your request will bring a copy promptly.

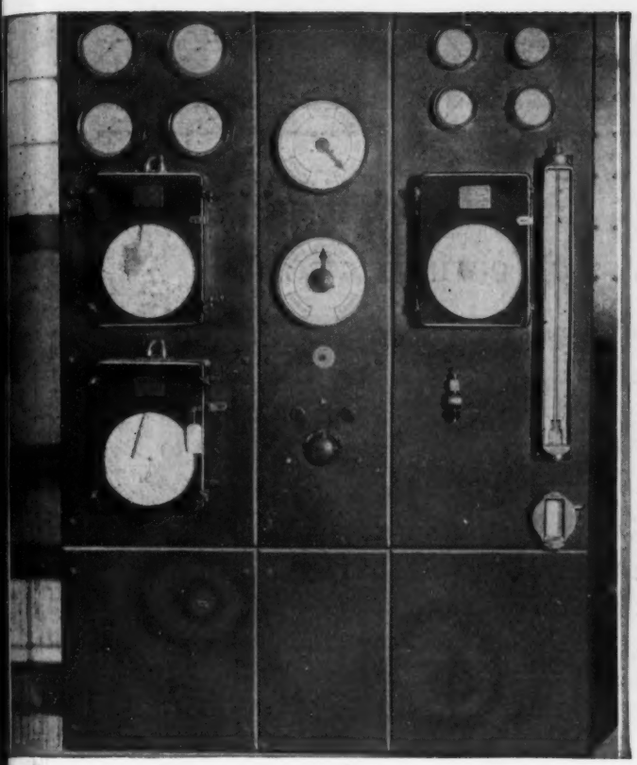


Portable Recording Millivoltmeter

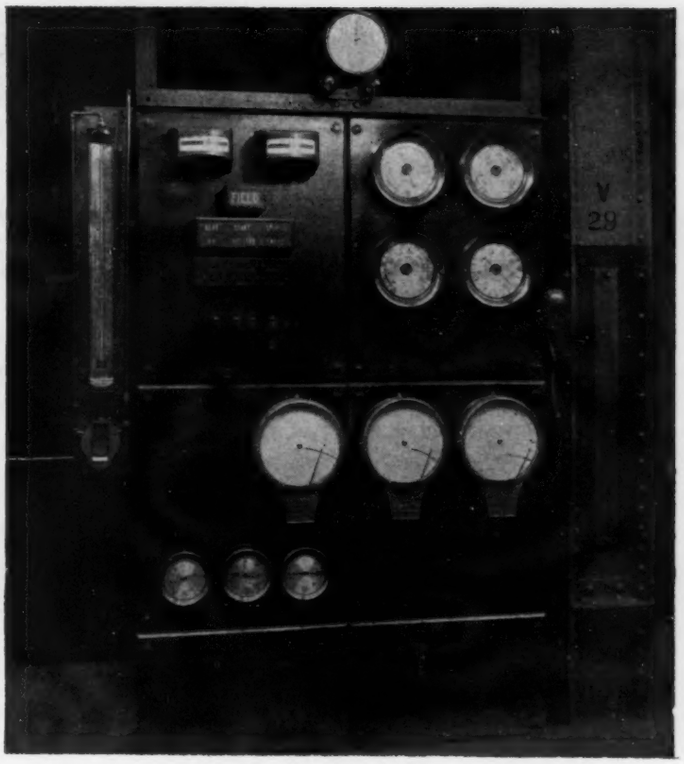
Recording Pyrometer

Recording Pressure Gage

Recording Wattmeter Wall Type



A Bristol's panel at the Devon plant of the Connecticut Light & Power Co.



Another large Bristol's board used by one of the largest power and railway companies in the world.

nginstruments for new construction

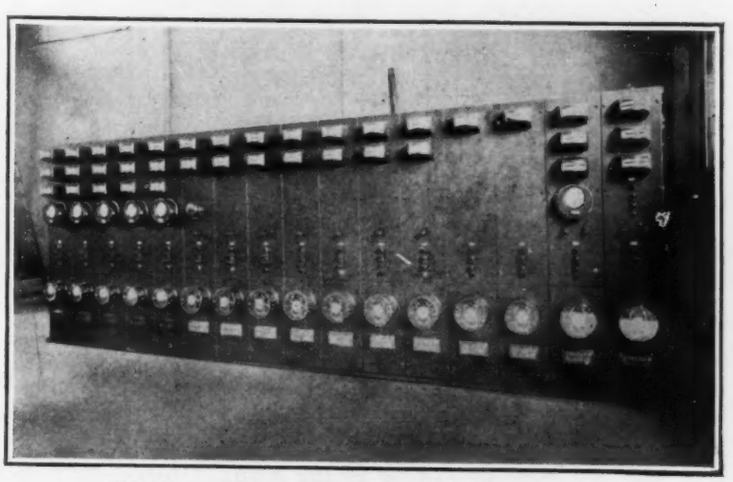
Whatever your instrument problem, Bristol has had the experience and actual service that really count. For 36 years the rank and file of engineers have learned to depend upon them—hence they are usually specified.

And no matter which type of our recording instruments you specify, you may feel sure of a highly dependable service. Greater plant efficiency at a cost consistent with the quality of service is enjoyed everywhere by Bristol's users.

Learn about the Bristol line, the most complete in the world. Write for descriptive catalogs.

FOR 36 YEARS Ask Any Technical Engineer MAKERS OF BRISTOL'S RECORDING INSTRUMENTS

THE BRISTOL CO., Waterbury, Conn.



Bristol's recording voltmeters used on feeder circuits by Southern Public Utilities Co., Charlotte, N. C.

Frequency Meter | Ammeter | Portable Wattmeter | Voltmeter | Wattmeter

CONNERY'S Improved EXPANSION STIFFENER

Practically all the leading public utilities have standardized on this modern flue construction

SHREVEPORT—the newly completed central station of the South Western Gas and Electric Company—Sargent & Lundy, Chicago, engineers and constructors, typifies the rapid progress being made by the South.

All boiler flues and uptakes are built with CONNERY'S Improved Expansion Stiffener construction, which makes them moisture proof and air-tight.

No sliding joints are included and all joints, corners and laps are electrically welded.

There are no points of concentrated stress. Expansion and contraction is taken up freely and all stresses are distributed. Consequently there is no trouble due to buckling or warping.

CONNERY'S Improved Expansion Stiffeners cost no more than ordinary construction. Why not specify them for all boiler flues, uptakes and air preheater ducts?

Write us for Bulletin

The new Shreveport Station of the South Western Gas & Electric Co., Shreveport, La. Sargent & Lundy, Chicago, Engineers and Constructors.

Here are a few more of many Connery installations:

Houston Light & Power Co.
Phoenix Utility Co.
Public Service Co.
Kearny, N. J.
Penn Central Power Co.
Day & Zimmermann
United Illuminating Co.
Westcott & Mapes
Western Electric Co.
J. G. White Eng. Co.
Monongahela West Penn. Pr. Co.
Sanderson & Porter
Metropolitan Electric Co.
W. S. Barstow Mngmt. Ass'n
Eastern Conn. Power Co.
Harry H. Hope Eng. Co.
Ford Motor Co.
Albert H. Kahn
Phila. Suburban Gas Co.
American Gas Co.
Southern Power Co.
Standard Oil Co.
Edison Elec. Ill. Co.
Chas. T. Main, Inc.
Virginian Railway Co.
Gibbs & Hill
Queensboro Gas & Elec. Co.
E. L. Phillips Co.
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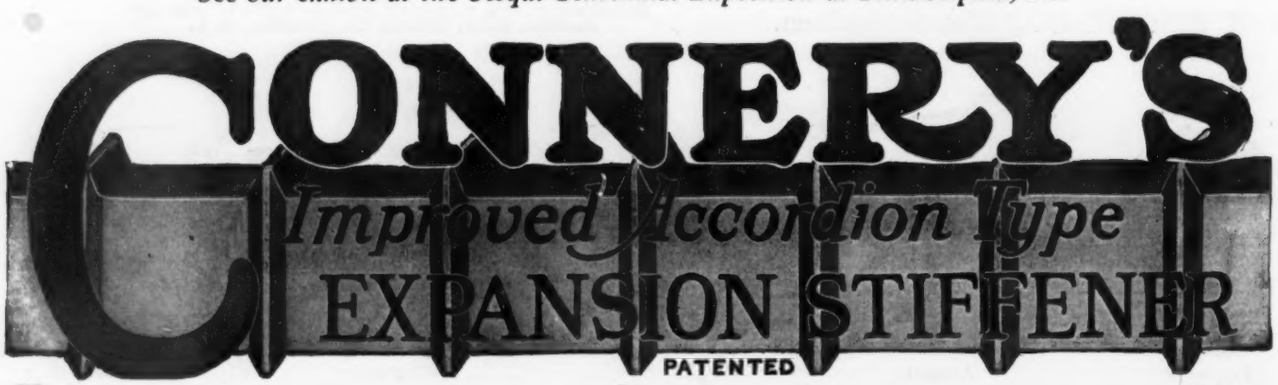
CONNERY & COMPANY, Inc.

New York Philadelphia Chicago

See our exhibit at the Sesqui-Centennial Exposition at Philadelphia, Pa.



208,000 kilowatts
in one Turbine-Generator unit

40 Times the capacity of the first large turbine (5,000 kw.) of 25 years ago

A G-E Turbine-Generator unit of this capacity is being manufactured for the State Line Generating Company, which is building a great power station on Lake Michigan to supply electric energy to the Chicago industrial district. It is the first unit for this station, which will have an ultimate capacity of 1,000,000 kilowatts.

Other G-E Turbines under construction, which are also pioneers of their class, are:

A 65,000-kw. machine for the Edison Electric Illuminating Company of Boston—the largest single-cylinder unit.

Two 94,000-kw. machines for the Southern California Edison Company—the largest tandem-compound units.

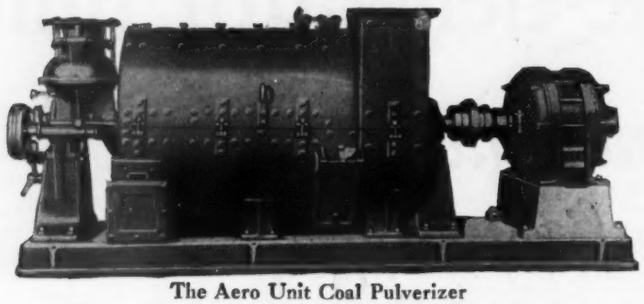
All of these G-E Turbines will be built to operate efficiently under modern high-temperature, high-pressure steam conditions. The machines are notable also on account of the fact that the 208,000-kw. and the 65,000-kw. machines will operate at a speed of 1800 r.p.m. and the 94,000-kw. machines at a speed of 1500 r. p. m.—the largest turbine generators now under construction to operate at these speeds.

The total capacity of G-E Steam Turbine Generators in service is 16,000,000 kw. Broad experience, plus General Electric's research work and well-grounded engineering, furnishes a foundation for any turbine development. The resultant reliability and efficiency of G-E machines are fully appreciated by progressive American engineers and public utility executives.

174-5

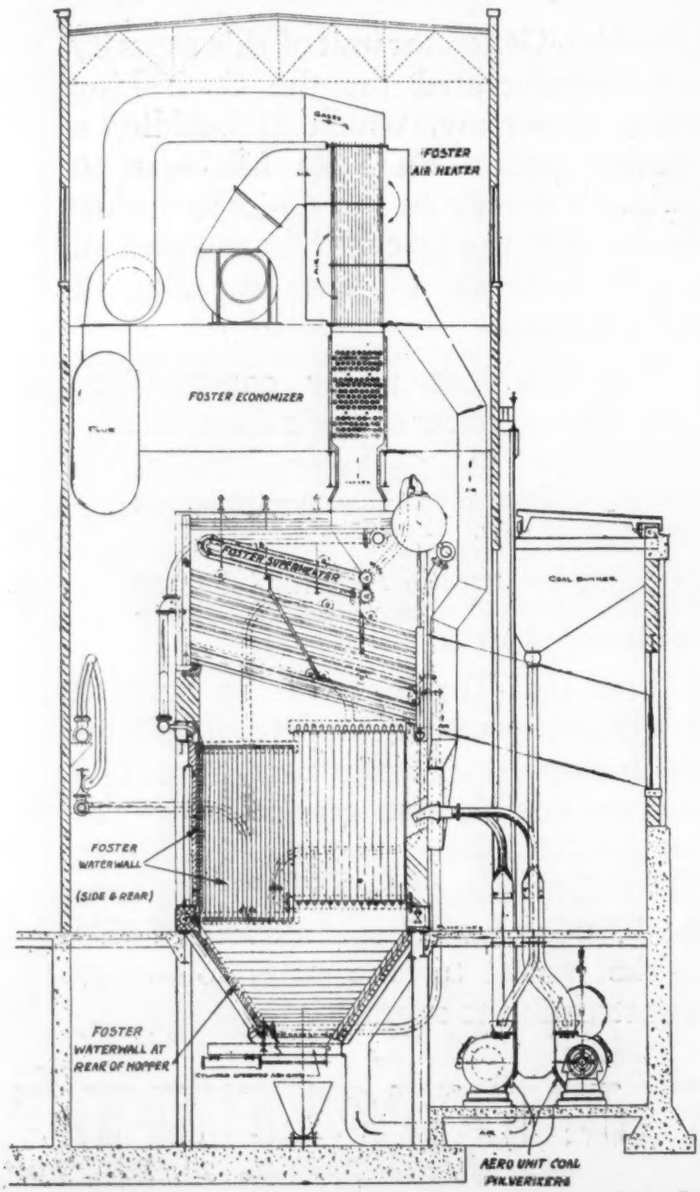
GENERAL ELECTRIC

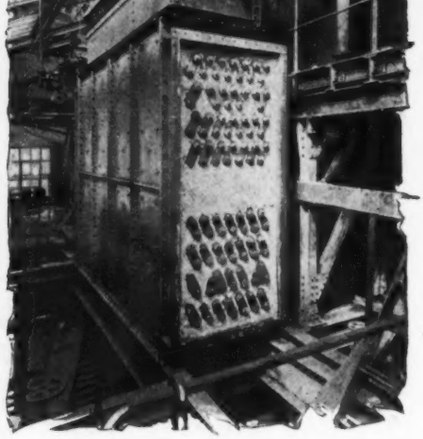
Complete equipment efficient



The Aero Unit Coal Pulverizer

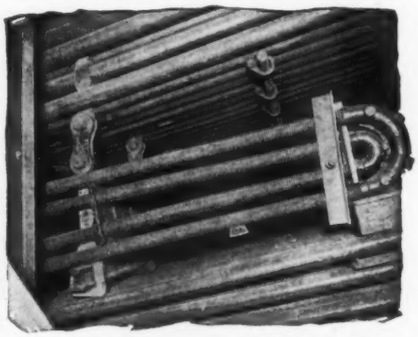
Delivers coal of a uniform fineness controlled by the operator, irrespective of wear and increasing clearances between the revolving and stationary parts. The coal can be pulverized to pass 99% through a No. 100 mesh screen, and high moisture content can be successfully handled.





The Foster Economizer

Provides complete countercurrent flow of furnace gases and feed water, which in many cases reduces the temperature of the flue gases below that of the water leaving the economizer. By using an individual economizer close to each boiler, air infiltration and radiation losses become negligible.



The Foster Convection Superheater

The Foster Extended Surface consists of steel tubing covered with cast iron rings or gills. It presents a far greater heat-absorbing surface than the bare tube construction, steadies the superheating effect, and greatly reduces danger of corrosion.

Power Specialty Company

Foster Superheaters, Economizers, Oil Heaters and Water Cooled Furnaces

111 Broadway, New York

Boston, Philadelphia, Pittsburgh, Cleveland, Detroit, Kansas City, Chicago, Denver, Dallas, Los Angeles, San Francisco, London, England

for more steam generation

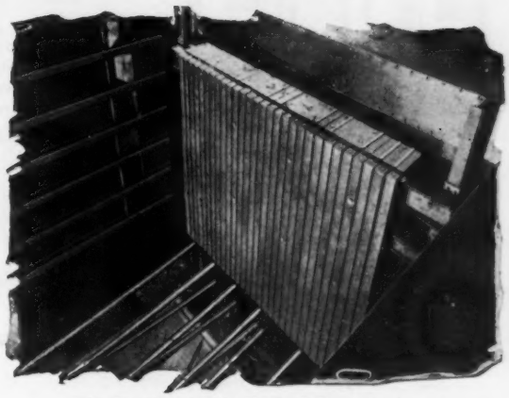
RECENT developments in power plant progress have clearly shown that maximum overall boiler efficiency necessitates complete control of the design and equipment entering into the construction of the steam generating units.

For any existing or proposed boiler, the Power Specialty Company will design, build and install the most suitable combination of heat transfer and coal pulverizing apparatus for maximum efficiency of steam generation.

This equipment includes the Foster protected surface convection superheater, radiant-heat superheater, economizer, water-cooled furnaces, and Aero unit coal pulverizer.

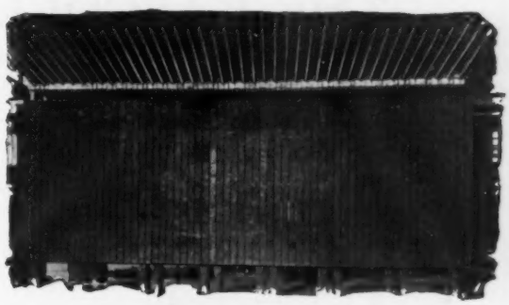
The results of over 11,000 installations made during the last 25 years have conclusively demonstrated the efficiency and durability of Foster design and construction.

Bulletins describing this equipment will be sent on request.



The Foster Radiant Heat Superheater

Absorbs heat directly by radiation from the burning fuel and from the heated brick walls of the furnace. Permits a wide range of superheat with relatively small heating surface, and effectively uses the radiant heat that otherwise causes high brickwork maintenance.



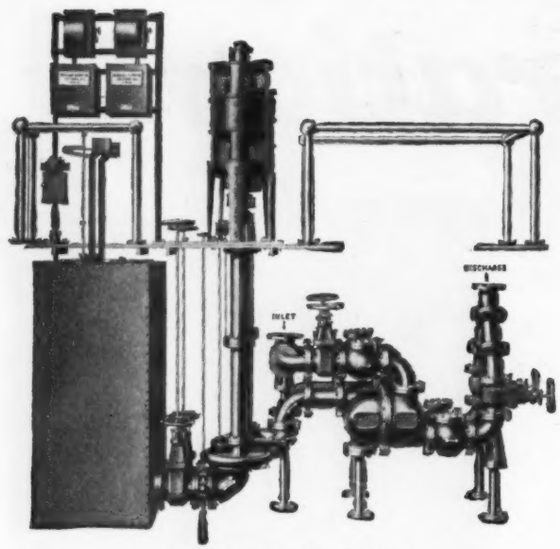
Foster Water-Cooled Furnace Surfaces and Water Backs

Foster Furnace Surfaces provide heat absorbing metallic walls to replace troublesome brickwork with its high cost and short life. Among the resulting advantages are—the elimination of heavy clinkers and clinker difficulties in stoker fired furnaces; increase in rapidity of boiler circulation, steam generation, furnace capacity, and marked reduction in furnace maintenance expense.

FOSTER

SUPERHEATERS
ECONOMIZERS
WATER-COOLED FURNACES
AERO UNIT COAL PULVERIZER

Let a "Chicago Flush-Kleen" Do That Disagreeable Task



Patented and Patents Pending

Quality Centrifugal Pumps for Every Purpose

SEWAGE CIRCULATING CONDENSATION
BILGE FIRE HOUSE VACUUM

The distasteful task of cleaning a strainer basket on a Sewage Ejector is no longer necessary.

Illustrated at the left is the Chicago "Flush-Kleen" Dry Basin Sewage Ejector unit. The construction of the "Flush-Kleen" is a development in Dry Basin Sewage Ejectors which entirely eliminates the old-fashioned strainer basket.

Let our Bulletin No. 126 tell you more about this new unit based upon the "Flow-Reversal" method.

"Flush-Kleen" Dry Basin Sewage Ejectors are now giving satisfaction in the Saenger Theatre, New Orleans; the Rome School, Rome, New York; and the Merchants and Manufacturers Building, New York City. Simplicity in construction of the "Flush-Kleen" strainer has been proven in the above installations where not a moment's trouble has been experienced.

Ask for Bulletin 126—Gladly furnished upon request.

CHICAGO PUMP COMPANY

2323 Wolfram St. Chicago, Ill.

THE BABCOCK & WILCOX COMPANY

85 LIBERTY STREET, NEW YORK

Builders since 1868 of Water Tube Boilers of continuing reliability

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THE BABCOCK & WILCOX COMPANY STEAM

WORKS
Bayonne, N. J.
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Makers of Steam Superheaters since 1898 and of Chain Grate Stokers since 1893

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SAN FRANCISCO, Sheldon Building
LOS ANGELES, 404-6 Central Building
SEATTLE, L. C. Smith Building
HAVANA, CUBA, Calle de Aguiar 104
SAN JUAN, Porto Rico, Royal Bank Building

SMITH & SERRELL
24 Washington Place
Newark, N. J.

FRANCKE FLEXIBLE COUPLINGS

For Motor, Turbine, Engine Drives

The Improved, Bushed Pin Type

handles all accidental shaft misalignments; cushions shocks and vibrations; is extensible one-half inch endwise; self-lubricated; any power, speed or service. All-metal, durable. Simple and safe. *Ask for Bulletin 378.*

SEND FOR BULLETINS

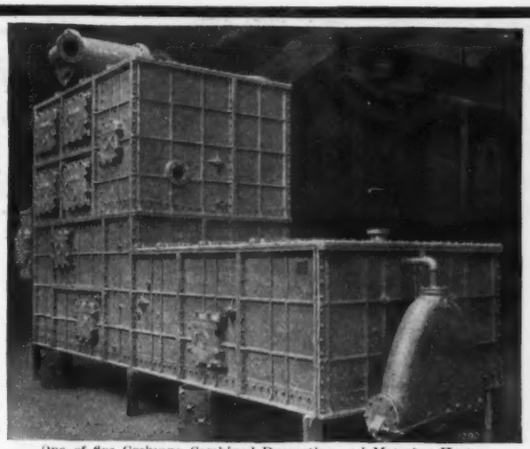
ELECTRIC CRANES
HAND CRANES
ELECTRIC HOISTS
I-BEAM TROLLEYS

MARIS BROS., Philadelphia

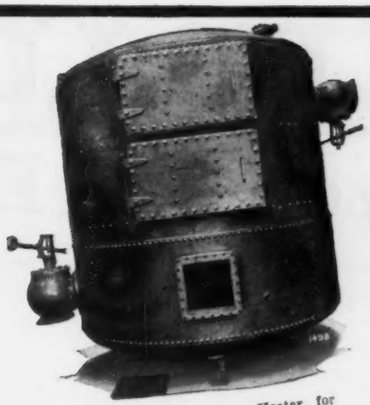
Over 600 in Service — Diesel builders since 1898

DIESEL BUSCH-SULZER ENGINES

Busch-Sulzer Bros-Diesel Engine Co
St. Louis Mo

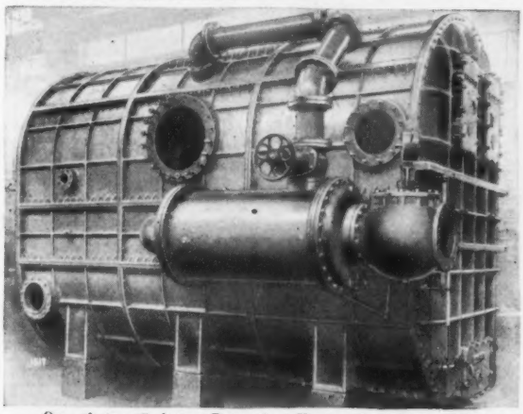


One of five Cochrane Combined Deaerating and Metering Heaters installed in Kearny Station; heating and deaerating capacity 400,000 lbs. per hr. each.

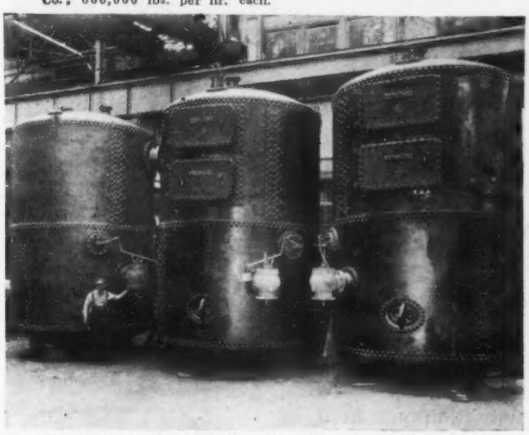


Cochrane Deaerating Heater for Najima Station, Toho Electric Co., Japan; 500,000 lbs. per hr.

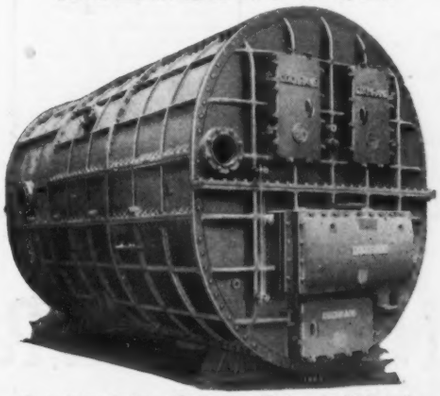
One of four Cochrane Deaerating Heaters installed by Union Electric Light & Power Co., St. Louis. Aggregate capacity, 1,525,000 lbs. per hr.



One of two Cochrane Deaerating Heaters for Toledo Edison Co.; 600,000 lbs. per hr. each.



Three Cochrane Combined Deaerating Heaters and Surge Tanks installed by Detroit Public Lighting Commission; 250,000 lbs. per hr. and 500 cu. ft. storage capacity, each.



One of two Cochrane Deaerating Heaters in Richmond Station; 540,000 lbs. per hr. each.

The Best Practice

In Feed Water Treatment

is to use Cochrane Deaerating Heaters, combined with air-tight surge tanks or V-notch meters, if desired, or with Cochrane Hot Process Softeners in jet condenser plants, thus avoiding all possibility of oxygen corrosion and scale in economizers and boilers.

The Cochrane Deaerating Heater is more efficient than a surface heater or a flash deaerator, as its use involves no loss of temperature head. It utilizes bled steam, auxiliary exhaust or evaporator steam and delivers oxygen-free, non-corrosive water at any temperature desired.

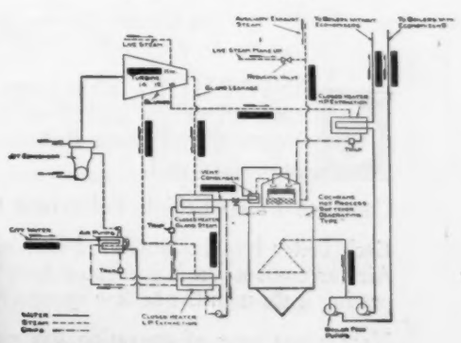
Ask for Publication M-1340

Cochrane Corporation

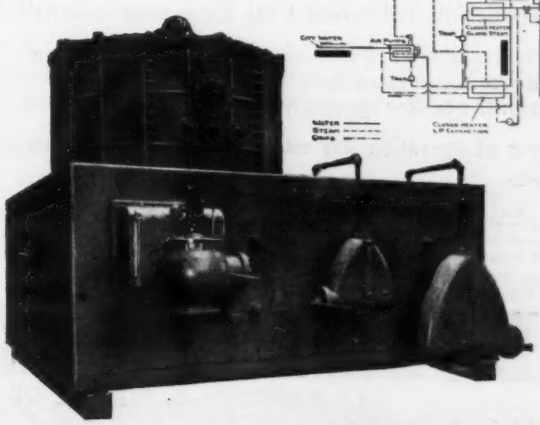
3197 North 17th Street, Philadelphia, Pa.

METERS	SOFTENERS	FILTERS	HEATERS
V-Notch	Hot Process	Pressure	Open—Closed
Pipe-Flow	Cold Process	Gravity	Steam Stack
Weighing			Metering
Volumetric			Deaerating
			Storage

DRAINERS	TRAPS	SEPARATORS	VALVES
for handling large quantities of water	Low Pressure High Pressure	Steam Oil Air Water	Back Pressure Atmospheric Relief Flow Check



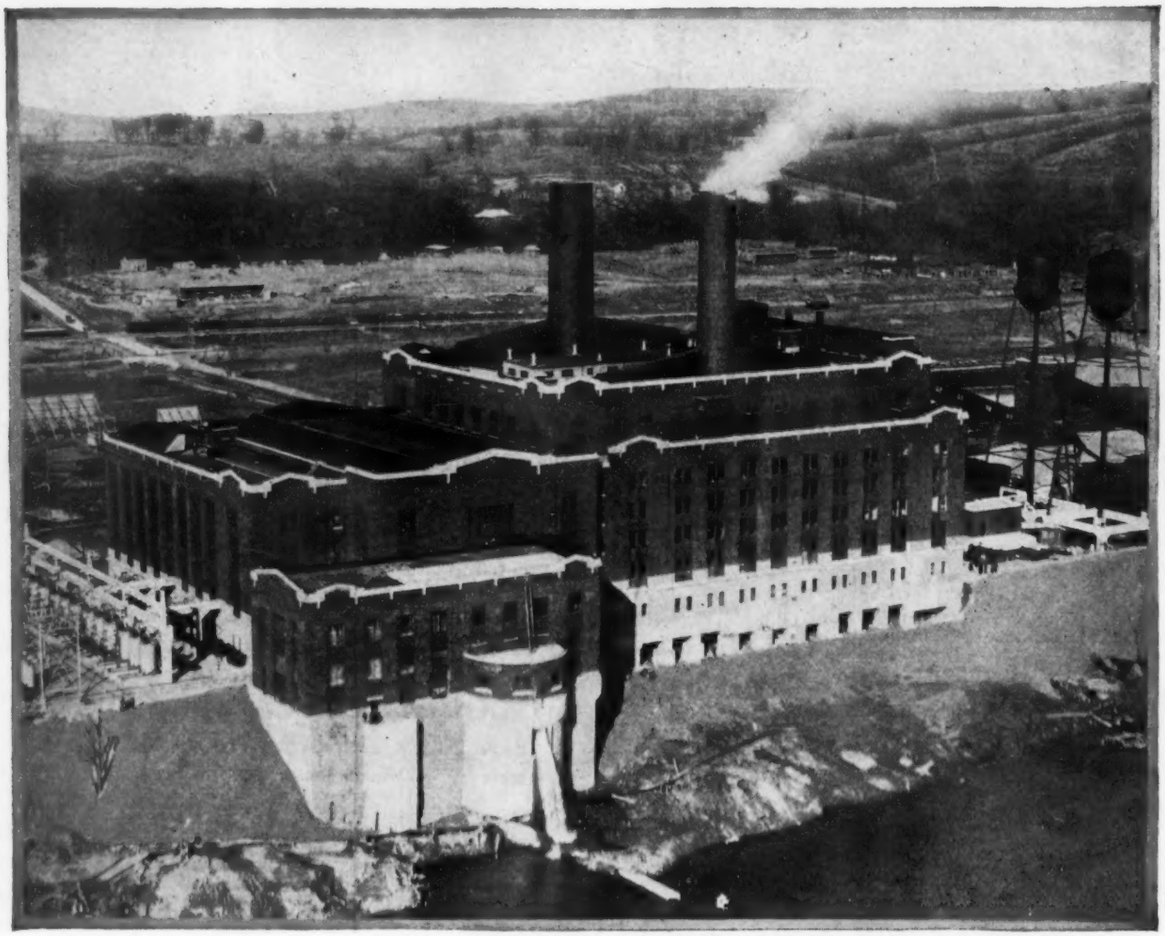
Heat Balance Hook-up of Narragansett Electric Light Co., Jenks & Ballou, Engrs., showing Cochrane Combined Deaerator and Hot Process Softener.



Cochrane Combined Deaerating Heater and Surge Tank supplied to Gulf States Utilities Co.; 300,000 lbs. per hr.

FULLER-LEHIGH
Pulverized Coal Equipment

IN Columbia Power Station



Columbia Power Station, Cincinnati, Ohio. Sargent and Lundy, engineers and constructors. The Foundation Company, general contractors for building construction.

CONFORMING to the latest practice in modern central station boiler operation, all of the 15,110 sq. ft. standard type and the 17,612 sq. ft. reheat Babcock & Wilcox Boilers at the Columbia Power Station are fired by pulverized coal.

Complete Fuller-Lehigh Pulverized Coal Equipment is installed.

Each boiler has six horizontal and nine vertical Fuller-Lehigh Flare Type Burners. Air for combustion is preheated by a Babcock & Wilcox Tubular Air Heater and by passing it through the hollow space within the boiler furnace and ash pit walls.

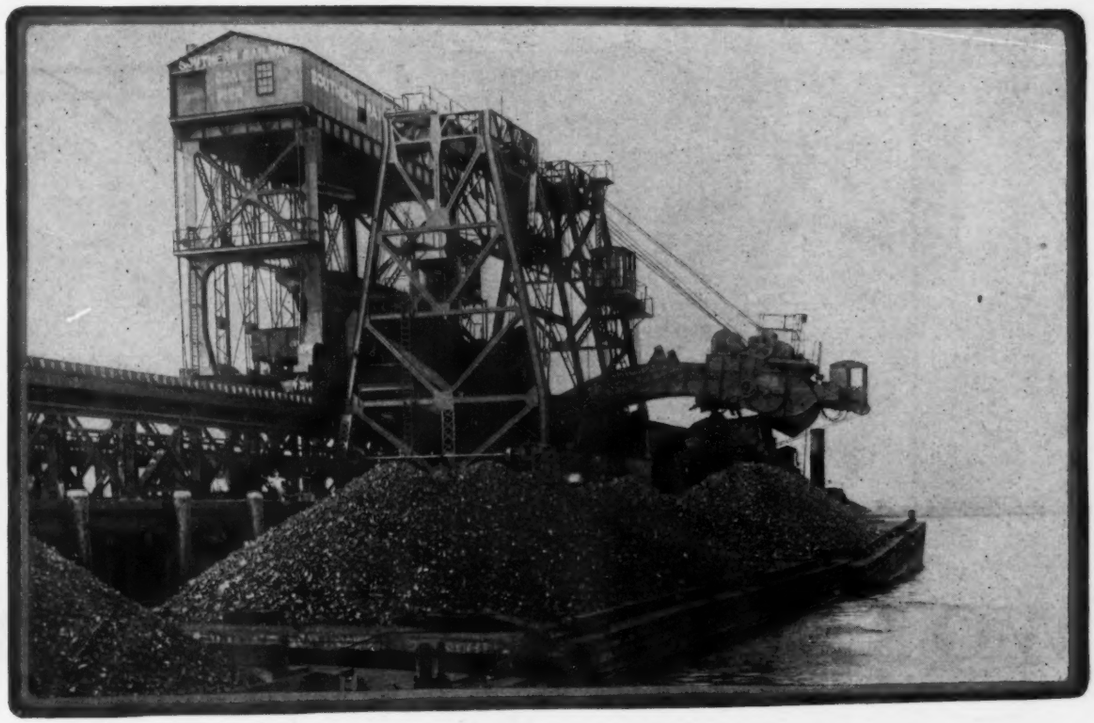
Nearly one year of operation has established the high economy and success of this method of firing.

Fuller-Lehigh Pulverized Coal Equipment includes all apparatus required for fuel preparation, transportation, and firing of boilers in large central stations and industrial plants and a complete unit mill system for direct firing of boilers in smaller plants.

We will be glad to point out the savings and operating advantages that can be obtained by pulverized coal firing under your boilers. Write for Bulletins:
No. 900—Pulverized Coal for Boilers Central Storage Systems.
No. 800—Unit Mills for Direct Firing of Boilers.

FULLER-LEHIGH COMPANY, Fullerton, Pa.
(A BABCOCK & WILCOX ORGANIZATION)

New York, Fuller-Lehigh Co., 50 Church St.
Chicago, Acers Poppenhusen Co., McCrmick Bldg., 322 So. Michigan Avenue
Boston, H. H. Leathers, 80 Federal St.
Salt Lake City, Harrison & Co., Atlas Bloci



Handles cargo or bunker coal—with a capacity of 3000 tons an hour

And you as operating factors in Central Stations are vitally interested in equipment that is to handle the enormous quantities of coal that you use.

W-S-M engineers have been serving your industry for years. They are able to advise you on coal-handling equipment of all sorts.

Your profits will increase according to the decrease in your operating expenses—be sure that your labor and equipment costs are minimized.

Detailed reports can be had from our engineering department. Write to them.

THE WELLMAN-SEAVER-MORGAN CO.

ENGINEERS CONSTRUCTORS MANUFACTURERS

Cleveland, Ohio

An Air Economizer with Removable, Reversible Chambers

Two Great Developments in

The unique design of Sturtevant Air Economizers for preheating combustion air *with utmost economy* has attracted the attention of the power plant industry.

In powdered coal installations burning low-grade fuel and in plants where the feed water to the boilers is heated to a high temperature through other sources,—such as bleeding steam from the turbines,—Sturtevant Air Economizers utilize the waste heat in the stack gases in place of or in connection with water economizers.

Sturtevant Air Economizers embody the most advanced engineering practice and possess several distinct and desirable features contributing to efficient operation and low maintenance.

One feature of especial interest to engineers is the individual unit chamber design. This practically doubles the life of the apparatus as each chamber is removable and reversible, thus making replacement a simple matter; but more important is the fact that the reversal of the "hot" and "cold" ends increases the life of the chamber.

Sturtevant Air Economizers can be adapted to any power plant and reduce power charges. We suggest you write for a copy of Bulletin 331 and see the advantages of this economizer.

STURTEVANT PRODUCTS for POWER PLANTS

FUEL ECONOMIZERS
- Cast Iron
- Steel Tube

Air Preheaters

Forced and Induced Draft Fans

Cindervane Fans

Steam Turbines

Reduction Gear Transmissions

Electric Motors

GENERATING SETS
- Engine
- Motor
- Turbine

Feeder Blowers

Dryer Fans

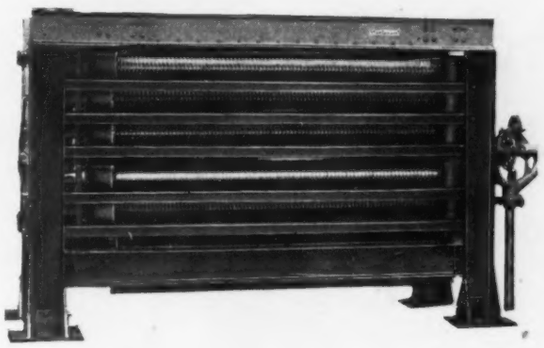
Turbo-Undergrate Blowers

Dust Blowers

Vacuum Cleaners

Air Washers

Transformer Fans



A Water Economizer with Lead Coated Extended Surface Steel Tubes

in Power Plant Economy

For years Sturtevant Cast Iron Economizers have been paying their owners high dividends by recovering hot waste gases for preheating boiler feed water. To meet the more modern conditions Sturtevant Lead Coated Extended Surface Steel Tube Economizers for use with high pressures have been introduced and have been hailed with highest approval by power plant engineers for their unique design and splendid performance.

This recent development in power plant equipment, which allows steel tubes to be used where before only cast iron was suitable, successfully combats the corroding effects of sulphuric acid in the waste gases on the outside of the tubes and of oxygen in the water on the inside of the tube by protecting the tubes with a lead coating. This covering on inside and outside is applied by a special process. In actual operation it has proved highly successful.

Another feature which distinguishes this economizer by its extraordinary efficiency is the extended surface. By a process developed by Sturtevant Engineers steel discs are put on steel tubes so tightly that an indentation appears on the pipe under every disc. This process secures the utmost in heat transfer from the gas to the water by means of the perfect contact between discs and tubes.

We have printed a bulletin No. 334 which is of interest to every power plant engineer. It fully describes this economizer. The large fuel saving obtained by the use of the Sturtevant Lead Coated Steel Tube Economizer offers you a chance to make a real showing in your plant. Our engineers will gladly give you any desired information.

B. F. STURTEVANT COMPANY

Plants located at

Hyde Park, Mass. Berkeley, Cal. Camden, N. J. Sturtevant, Wis. Framingham, Mass. Galt, Ontario

Sales Engineering Offices

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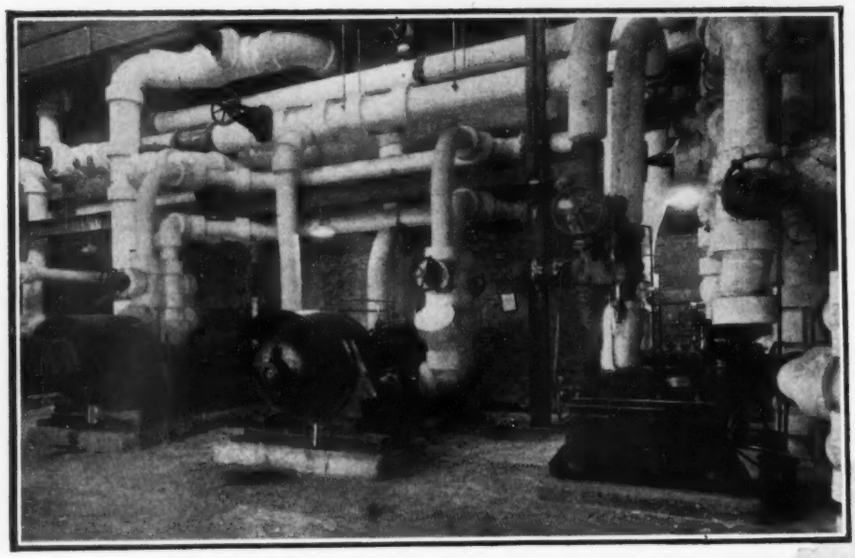
Two Bethlehem Turbine-driven Centrifugal Boiler-feed Pumps at Narragansett Plant



Boiler-Feed pumps at the Narragansett Plant Showing the Bethlehem Turbine-driven Centrifugal Pumps at the right.

TWO Bethlehem (Weir Type) steam Turbine driven Centrifugal boiler feed pumps are installed in the plant of the Narragansett Electric Lighting Company at Providence, R.I.

These pumps are of the single stage type and each delivers 1,000 gallons per minute at 485 pounds pressure. One unit is used on the main feed lines; the other supplies an emergency feed system.

Efficiently designed and carefully constructed, Bethlehem Pumps meet the exacting requirements of modern power plant practice, insuring dependable equipment for hard continuous service.

Bethlehem Equipment for Power Plants Includes:

Bethlehem (Dahl) Mechanical Fuel Oil Burning System

Diesel Oil Engines

Motor- and Turbine-driven single-stage centrifugal Boiler Feed Pumps and General Service Pumps

Motor-driven reciprocating General Service Pumps

Steam-engine-driven single-stage centrifugal Circulating Pumps

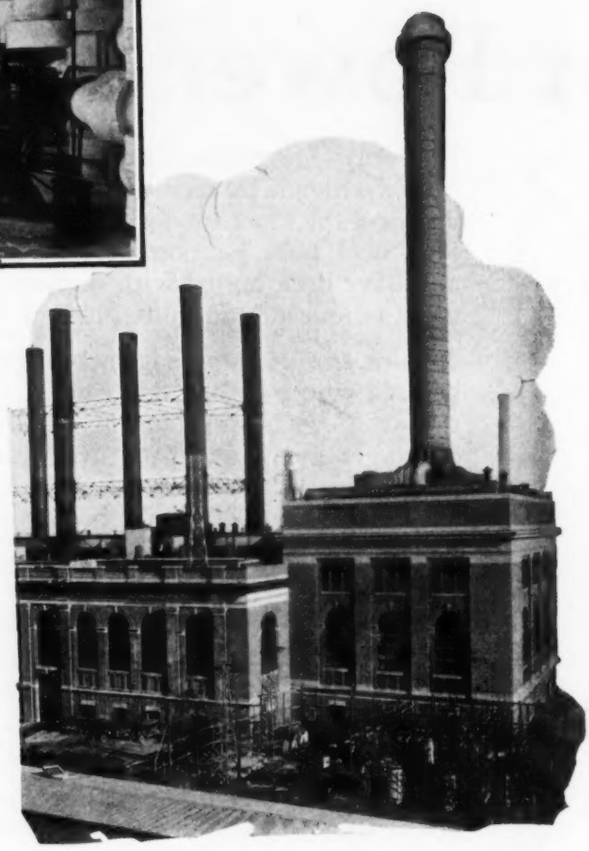
Motor-driven single-stage centrifugal Oil Pumps

Submerged-tube Evaporators

Steam-driven reciprocating Fuel Oil, Lubricating Oil and Boiler Feed Pumps

Motor- and Turbine-driven single-stage centrifugal Extraction of Condensate Pumps

Surface Feed Water Heaters



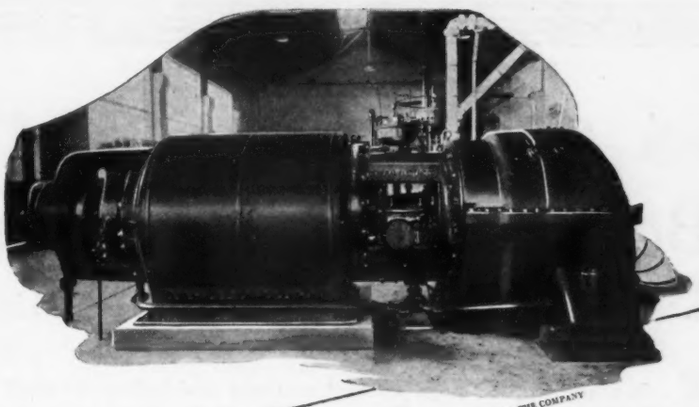
Narragansett Plant of the Narragansett Electric Lighting Company, Providence, R. I. Jenks and Ballou, Engineers

BETHLEHEM SHIPBUILDING CORPORATION, LTD., BETHLEHEM, PA.

GENERAL SALES OFFICES: 25 BROADWAY, NEW YORK CITY

DISTRICT OFFICES: Boston, 100 Milk St.; Philadelphia, Widener Bldg.; Wilmington, Foot of West St.; Baltimore, South and Water Sts.; Cleveland, Union Trust Bldg.; Chicago, Monadnock Bldg.; San Francisco, Matson Bldg.

BETHLEHEM



100% satisfaction

ADDRESS ALL COMMUNICATIONS TO THE COMPANY

THE GRAND JUNCTION ELECTRIC, GAS AND MANUFACTURING COMPANY

GRAND JUNCTION, COLORADO

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CHAS. L. TUTT, SECRETARY AND TREASURER
J. STEWART, GENERAL MANAGER
A. E. ANDERSON, GENERAL SUPT

Garden City, Kansas,
October 12th, 1925.

Mr. A. L. Jones, District Engineer,
General Electric Company,
D e n v e r, Colorado.

Dear Mr. Jones:

Have just returned from Grand Junction and thought would write and let you know that the new turbine is performing just wonderfully. In fact, it is a 100 percent installation and is giving perfect satisfaction in every way.

It's cheapness in operation is phenomenal.

Very truly yours,

General Manager

JS:C

ONLY performance that is without reproach could inspire a G-E Turbine user to unreserved testimony such as this. General Electric's claims for the product of its steam turbine factories are amply verified by the recommendations of satisfied customers throughout the world.

GB-9

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y., SALES OFFICES IN ALL PRINCIPAL CITIES

Riley Has a Type For

Whether Big Boiler or Small Boiler

Anthracite, Coke Breeze, Eastern Bituminous

Riley Super-Stoker is made for the large central stations and industrial plants where high capacity and maximum efficiency are desired. Built in depths up to 20′ and having a coal burning capacity per retort up to 3000 pounds of coal per retort per hour, it is applicable to boilers of large size.

Riley Standard Stoker is a multiple retort, inclined, underfeed stoker for medium and large sized boilers. Particularly adapted where heavy overloads or fluctuating loads are carried. Exclusive features include: Reciprocating Retort Sides, Moving High Side Wall Tuyeres, 2-speed Gear Box, Rocker Dump, Safety Shearing Pin.

Harrington Traveling Grate Stoker is of the forced draft, traveling grate type. It is adapted to all types of boilers from 250 hp. to the largest sizes. The Harrington Stoker is burning successfully a wide range of fuels. These fuels include bituminous coal, lignites, all sizes and characters of anthracites including river dredgings, and coke breeze. The Harrington Stoker has many unique and exclusive features which account for its success in burning this wide range of fuels in an economical and efficient manner.

Lateral Retort Stoker is an all underfeed multiple retort, side cleaning stoker requiring no basement. This brings to smaller boiler units (from 150 H.P. to 500 H.P.) the proved advantages of underfeed, multiple retort, stoker firing.

Jones Side-Dump Stoker has the basic Jones features and in addition, a side-dump, forming a self-cleaning mechanism. Only slight excavation is required; the cost is low. This stoker gives high efficiency and has a fuel burning capacity of 1,200 to 1,800 pounds of coal per hour.

Jones Standard Stoker is applied to boilers from 50 H.P. to 150 H.P. It is moderate in first cost, and since it requires practically no excavation for installation, can be economically installed in existing plants. This stoker has a fuel burning capacity of 800 to 1,200 pounds of coal per hour.

Jones Industrial Furnace Stoker is used in industrial heating operations, metallurgical and chemical furnaces. Fuel burning capacity is 60 to 800 pounds of coal per hour.

Murphy Automatic Furnace is designed for any type of boiler from 50 H.P. up to the larger sizes for which the multiple retort underfeed stoker is best suited. It is a natural draft furnace and requires no fan or blower equipment. Particularly suited for small or medium size boilers carrying a steady load.

Manufacturing all Types of Combustion Equipment

Riley Stoker Corporation

RILEY STOKER

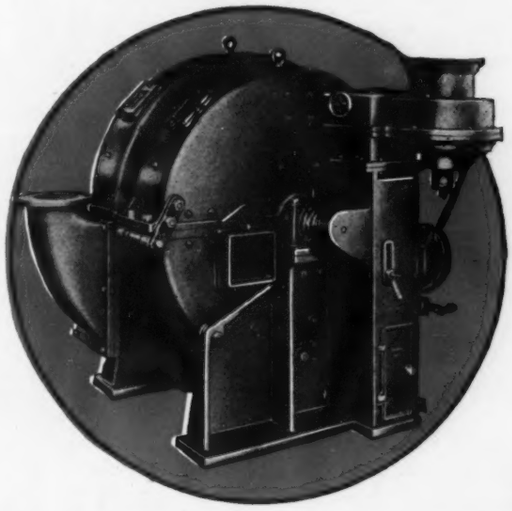
"RILEY" Underfeed Stokers — *"JONES" Underfeed Stokers* — *"HARRINGTON" Traveling Grate Stokers*

"MURPHY" Automatic Furnaces —— *Pulverized Coal Installations*

Every Combustion Need

Mechanical Stokers or Pulverized Coal

Pittsburgh, Illinois, Iowa Coals or Lignites



Riley Atrita Unit Pulverizer

These Characteristics of
the Atrita Unit Pulverizer
Result in Real Economy

Dependability
Unusually Low Power Consumption
Sustained Fineness of Pulverization
Ability to Handle Wet Coal
Low Maintenance

Ask for Bulletin 92.

Naturally our Recommendations are Unbiased

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Riley Engineering and Supply Co., Ltd., Toronto Riley Stoker Co., Ltd., London

Riley Stoker Corporation

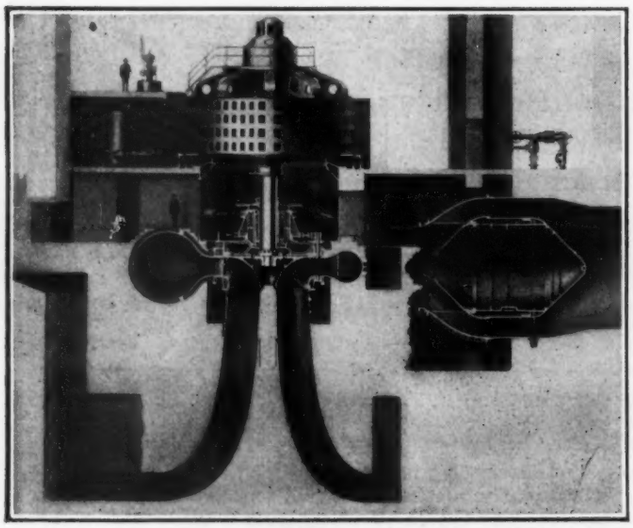
I.P.MORRIS

The Wm. Cramp & Sons Ship

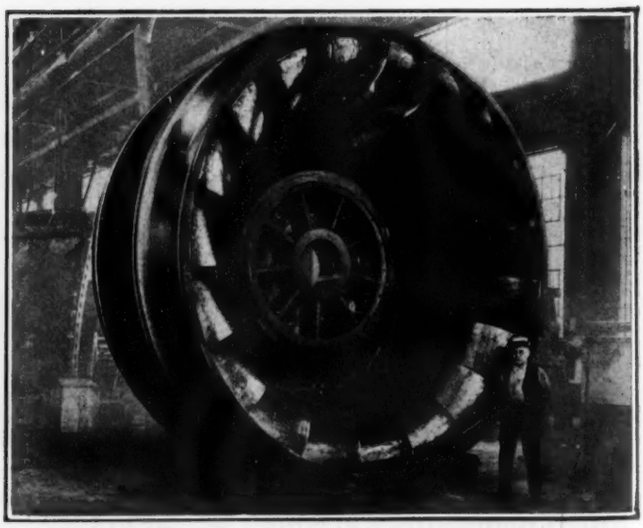
New York Office: 100 Broadway Philadelphia

STATION 3-C OF THE NIAGARA FALLS POWER COMPANY

A NEW WORLD'S RECORD FOR HY



SECTIONAL ELEVATION VIEW OF ONE OF THE 70,000 HORSEPOWER TURBINES FOR THIS STATION



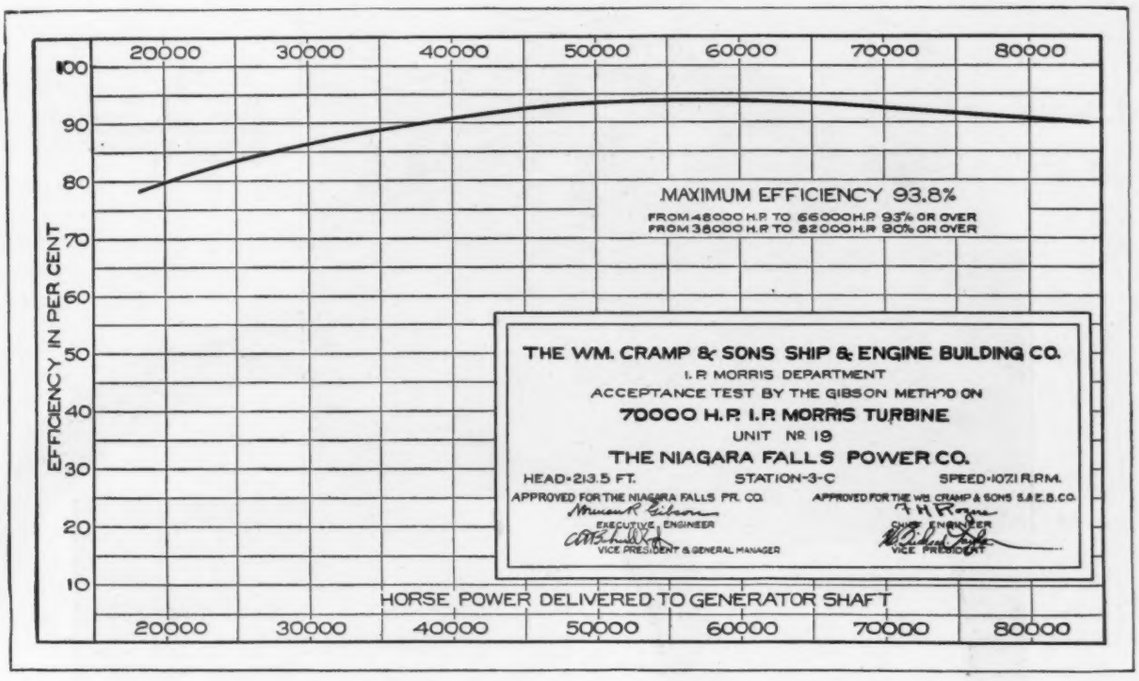
SHOP VIEW OF THE TURBINE RUNNER FOR THIS UNIT

TURBINES

& Engine Building Company

U. S. A.

Birmingham Office: American Trust Building



DRAULIC TURBINE PERFORMANCE

RESULTS OF OFFICIAL TEST

Maximum efficiency of the Turbine..... 93.8%
Throughout a range of 26.0% of rated capacity efficiency exceeds..... 93.0%
Throughout a range of 63.0% of rated capacity efficiency exceeds..... 90.0%

This unit which includes an I. P. Morris turbine and a generator of General Electric Company manufacture, developed a combined efficiency of 92%, which is a world's record in hydro-electric unit performance.

Both turbine and generator efficiencies were accurately determined from independent field tests conducted by Engineers of the Niagara Falls Power Co. and approved by Engineers representing both the United States and Canadian Governments who were present during tests.

I. P. Morris turbines recently installed at Niagara Falls have, under official test, developed the following efficiencies:

37,500 H. P. turbine for Niagara Falls Power Co. Plant No. 3-B..... 93.0%
55,000 H. P. turbine for Hydro-Electric Power Commission of Ontario, Queenston Plant.. 93.3%
58,000 H. P. turbine for Hydro-Electric Power Commission of Ontario, Queenston Plant.. 93.8%
70,000 H. P. turbine for Niagara Falls Power Company, Plant No. 3-C..... 93.8%

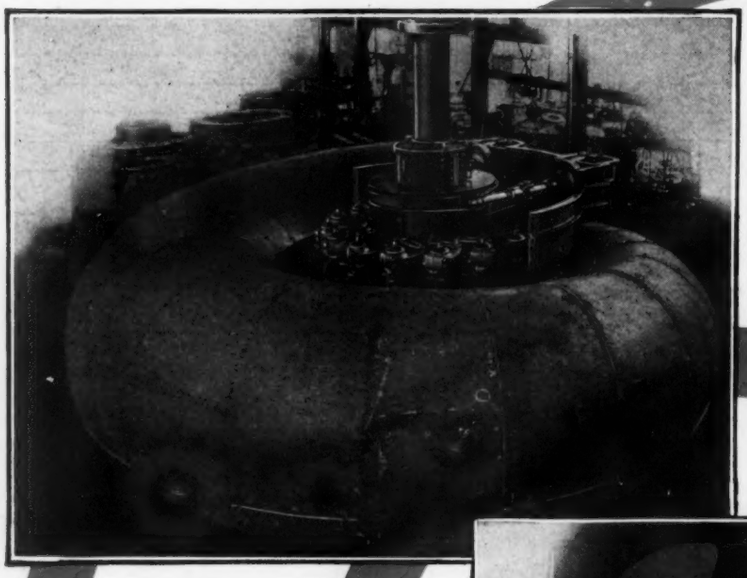
Designers and builders of the Johnson Hydraulic Valve and the Moody Spiral Pump

---

ASSOCIATED COMPANIES

THE PELTON WATER WHEEL CO., San Francisco and New York
DOMINION ENGINEERING WORKS, LTD., Montreal, Canadian Licensees
SOCIEDADE ANONYMA, HILPERT, Rio de Janeiro, Brazilian Licensees

Three more jobs showing can solve



At the left, one of 29,600 H.P. Smith turbines for Columbus Electric & Power Co., Columbus, Ga.

Illustration to the right, is high speed runner for Backus-Brooks Co., Kenora, Ontario.

Below is shown two Roller Gates as installed at Pennsylvania Power & Light Company's Wallenpaupack Development.

how S. Morgan Smith Co. any hydraulic problem

29,600 H.P. Turbine for Columbus (Ga.) Electric & Power Co.

The illustration at the top shows one of two S. Morgan Smith units of 29,600 H.P. at 120-ft. head and 150 R.P.M. furnished for the Columbus (Ga.) Electric & Power Co. Each turbine has a 14-ft. diameter steel plate scroll case. The scroll case is of the true spiral plate steel type, which have very definite and valuable features built into them that make their use safe. Our right to make SMITH TRU-SPIRAL CASES has been fully sustained by recent U. S. Court decision because of inherent merit over another type.

High Speed Turbine for Backus-Brooks Co.

In the center is shown the high speed four-blade Bell type runner as used in five vertical shaft hydraulic turbine units for the Norman Dam development of Backus-Brooks Co. at Kenora, Ontario. Each unit develops a maximum of 3,775 H.P. at 120 R.P.M. under 24-ft. head. The illustration shows how the projected area of the blades is equal to the full circle, thus giving stable and satisfactory governing characteristics and avoiding the troubles experienced in many plants with some types of so-called propeller turbines.

Roller Gate for Pennsylvania Power & Light Co.

At the foot of the page opposite is shown an installation of two roller gates in connection with the Wallenpaupack Development of Pennsylvania Power & Light Co. These roller gates are to control openings 14 ft. high and each 67.5 ft. clear width. The lift is 13 ft. and the rollers are operated by electric motor or hand-operated hoist, as may be desired. Briefly, the roller gate equipment consists of the following essentials: The roller proper, to the ends of which are attached cast steel gear segments to roll upon racks, and a hoisting mechanism to operate same. The ends of the rollers are sealed against leakage.

The advantages to be gained by the use of these roller gates as compared with Tainter gates and the like are the long clear widths of spillway easily and safely attainable without intermediate piers, the large circular cross section being very strong; no trouble at all is experienced with even large ice cakes or trees or the usual debris and trash floating downstream; a high degree of tightness and, therefore, minimum loss of water; ease of operation; simplicity of design and insensitiveness. Most of all, they are thoroughly reliable and their dependability has been amply demonstrated.

EVERY PIECE OF SMITH APPARATUS CARRIES THE SMITH WARRANTY

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Specify Woodward Governors to insure a Completely Successful Water Wheel Installation

Woodward Governors are designed and built by an organization that has specialized in this one thing for more than fifty years.

This specialization has resulted in Governor developments that have contributed materially to the economical and practical operation of Hydro-Electric plants.

Many engineers and managers have come to know Woodward Governors for their excellence of performance and insist on them when they order water wheels.

Woodward Governors are today used with the finest turbines and govern water wheels of all types. They are designed to provide for every hydro-electric power plant requirement.

There are no involved adjustments to make upon installation—no after-purchase costs.

Fifteen Type HR Woodward Governors are here shown controlling vertical shaft turbines coupled direct to alternating current generators for Bangor Hydro-Electric Co., Veazie Plant, Bangor, Maine.

This company is about to install a new unit in another plant which is completely automatic. This unit will be controlled by a Woodward Governor fitted for automatic operation.

Hundreds of similar Hydro-Electric plants thruout the country are experiencing the highest type of Governor performance because they insisted on the installation of Woodward Governors.

WOODWARD GOVERNOR CO.

Rockford, Illinois

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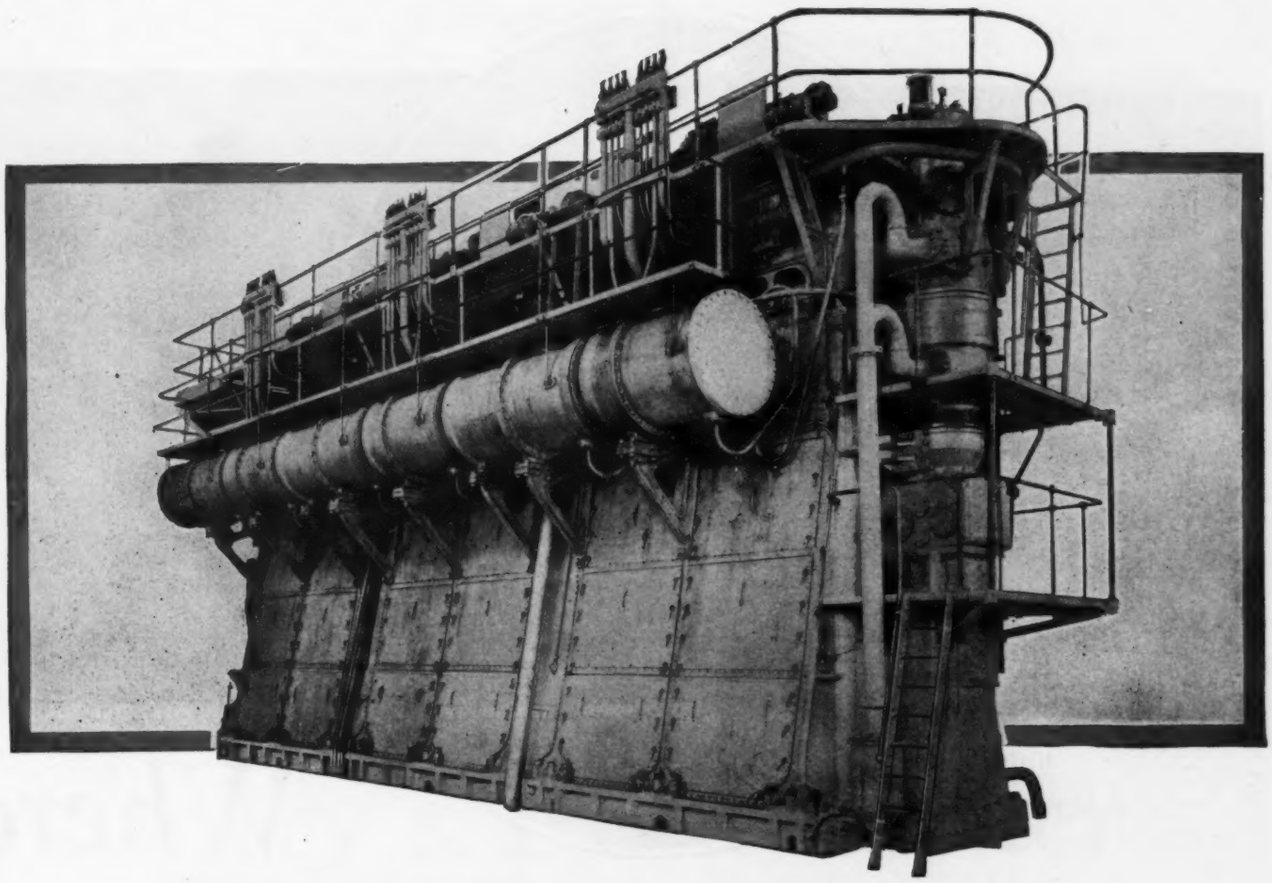
A new, interesting and informative Woodward Governor Catalog is now ready for mailing. We will gladly send a copy to you upon request.

WOODWARD

WATER WHEEL GOVERNORS



Diesel Engine Power *for* High Efficiency

Sustained high thermal and mechanical efficiencies give to purchasers of Bethlehem Large Unit Type Oil Engines reliable assurance against economy losses that would depreciate the initial investment.

Depreciation from service can be conservatively figured as being no greater than that of the steam engine.

For comparable sizes, a Diesel engine produces more useful power per B.t.u. input at all loads, than is obtainable from any other type of commercial heat engine.

From fuel to switchboard the thermal efficiency of a Diesel-Electric plant will approximate 30 per cent, as against 10 per cent for an average steam-operated industrial plant.

Bethlehem Large Unit Type Oil Engine is built in units of 2, 4, 6 and 8 cylinders in capacities ranging from 1,000 horsepower upward.

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Where

McGraw-Hill has its fingers on the throbbing pulse of American Industry. Its investigators and statisticians are continually garnering facts and figures that help to make McGraw-Hill Publications vital forces in industry. In a never-ceasing stream these comprehensive data pour into the McGraw-Hill organization. Then through the McGraw-Hill Publications the information is disseminated among the particular industries to which it may apply—authoritative, virile facts on the trends and developments of industry.

Chemical and Metallurgical Engineering provides dependable statistical information for the process industries. Its weighted price index is used as an authority in Secretary Hoover's "Monthly Survey of Current Business"—in the bulletins issued by large metropolitan banks—and in leading newspapers. Manufacturers and consumers of industrial chemicals use it as a guide in charting production and consumption facts and trends. Equipment manufacturers gauge conditions by it.

Engineering and Mining Journal is the publication through which come facts and figures of vital importance to the stabilization and stimulation of the metallic and non-metallic mining industry. Its market quotations are accepted as a basis for computing contracts in the industry. And its practical information on methods and machinery for eliminating waste and increasing efficiency and profits are welcomed by its subscribers.

Electrical World was the first to collect data on the operations and the development programs of the electrical industry, and has continued to present these statistics week after week, charting in detail, thereby, the progress of this great servant industry. It also publishes each month a national and sectional barometer of activity in each of the primary manufacturing industries. This barometer is based upon reports of electrical energy consumption received monthly from almost 2,000 large manufacturing plants which consume approximately eight-billion kw.-hrs. per annum. This barometer is accepted by economists as the most timely, diversified and sensitive indicator of industrial activity available.

Engineering News-Record's construction cost and construction volume index numbers are the authoritative gauges in the field of industrial and engineering construction. Its compilation of value of contracts awarded the country over in the various classes of construction (a monthly service for 14 years) gives the engineer, contractor, manufacturer of equipment and the material dealer an accurate running account of the financial value of the business from which they derive their living.

Approximately 15,000 sources are regularly consulted by McGraw-Hill editors, marketing counselors and statisticians in keeping McGraw-Hill data on industry and electrical and radio trade accurate and up to date.

In addition 220,000 McGraw-Hill subscribers constitute a source that is consulted from time to time for specific data relating to production and buying

41 McGraw-Hill men devote their time exclusively to collating and interpreting data for editorial presentation to McGraw-Hill subscribers and for the information of industrial advertisers.

More than 200,000 vital questionnaires are dispatched yearly from McGraw-Hill offices, many of them going to the same sources week after week and month after month in order that McGraw-Hill reports may be up to the minute. These data are published regularly in the McGraw-Hill Publications and are quoted from them regularly in 134 leading newspapers published in industrial centers.

Industry's Data Center

And so with all other McGraw-Hill Publications. Industry's dependence upon them is the logical outcome of centralizing the collective resources of the McGraw-Hill Publishing Company in obtaining information and disseminating it scientifically. It is from this storehouse of industrial data and the experience in acquiring the facts that has come the ratings of industrial markets and the formula for selling them efficiently. This knowledge is epitomized in the following McGraw-Hill Four Principles of Industrial Marketing:

MARKET DETERMINATION—An analysis of markets or related buying groups to determine the potential of each. With a dependable appraisal of each market, selling effort can be directed according to each market's importance.

BUYING HABITS—A study of the selected market groups to determine which men in each industry are the controlling buying factors and what policies regulate their buying. Definite knowledge eliminates costly waste in sales effort.

CHANNELS OF APPROACH—The authoritative publications through which industries keep in touch with developments are the logical channels through which to approach the buyer. In a balanced program of sales promotion these publications should be used effectively and their use supplemented by a manufacturer's own literature and exhibits.

APPEALS THAT INFLUENCE—Determining the appeals that will present the product to the prospective buyer in terms of his own self-interest or needs.

The application of these Four Principles of Industrial Marketing to your business must result in greater efficiency and lowered selling cost.

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McGraw-Hill marketing counselors are at your service, ready to show you how you can effectively use Industry's Data Center.

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FROM New York to the Orient—Kellogg penstocks and high pressure steam piping have built up a splendid reputation. The Kellogg Upset Lap Joint is an indication of the kind of service Kellogg engineers are rendering to the public utilities. It has two great advantages. 1. It can be installed quickly, 2. And by unskilled labor. This is because it is simply bolted together. Full details upon request.

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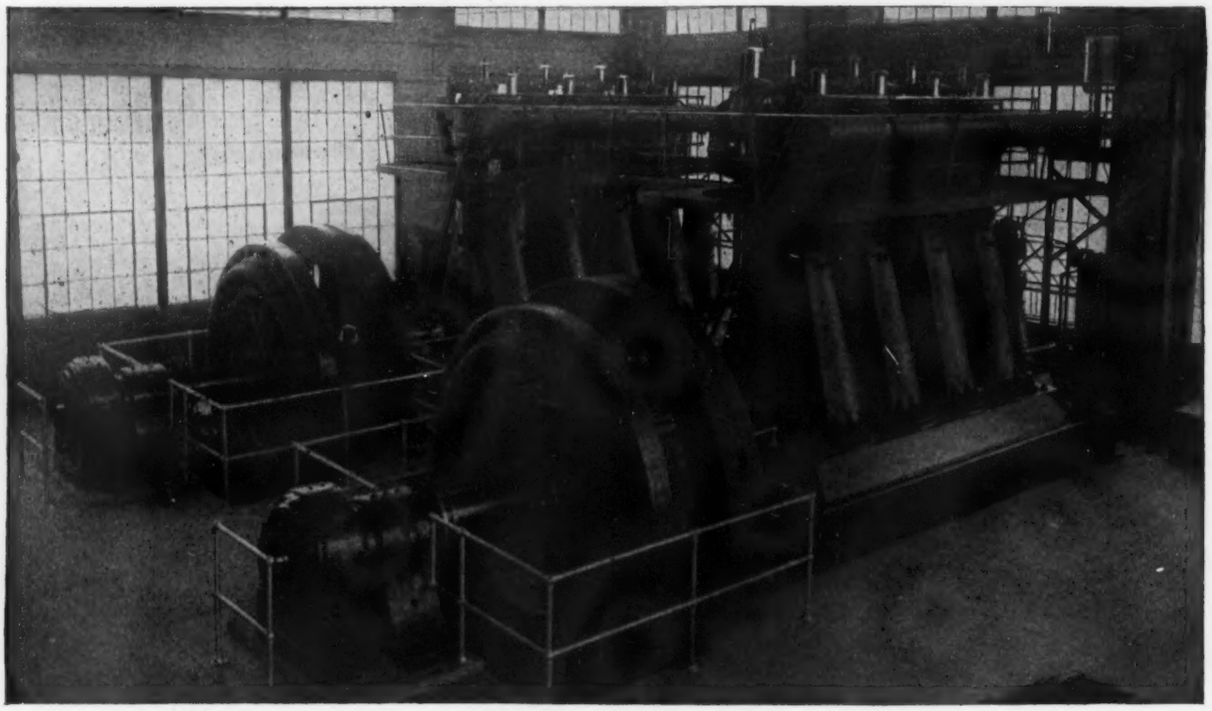

Two 500-b. hp. McIntosh & Seymour Diesel Engines driving 437-kva., 60-cycle alternators at Nogales, Ariz. These units furnish current for general lighting and power purposes including irrigation. The transmission lines extend to mines and mining camps in the mountains nearby, and even with these expensive lines, the efficiency of the station admits of furnishing power very profitably to both the owner and the mines. For "off-peak" load, the station serves a large motor-driven ice machine furnishing cold storage facilities and ice for general use and icing refrigerator cars.

Diesel engines do perfect work with low-grade oil

McINTOSH & SEYMOUR units will operate on any crude or semi-refined oil which is reasonably free from water, sulphur and dirt and is fluid enough to feed.

As a typical example, the above engines use only California oil containing about 50 percent asphalt, and so heavy as to require perliminary heating before it can be pumped. Notwithstanding this, the cylinders, pistons and rings show no deposits and require no cleaning beyond what is given at the twice-a-year examinations this type of engine should have under any conditions.

Upon test by the purchaser's consulting engineer after several months' operation, the fuel consumption was shown to be at the rate of over 14 kw.-hr. per gal. and the lubrication was accomplished with less than 5 gal. per 24 hr. for both engines for all purposes.

If you hesitate to adopt Diesel power because of the quality of fuel available, let our Engineers show you how and why full benefits can be obtained with practically no difficulty. At least ask for literature.

BY INVITATION MEMBER OF

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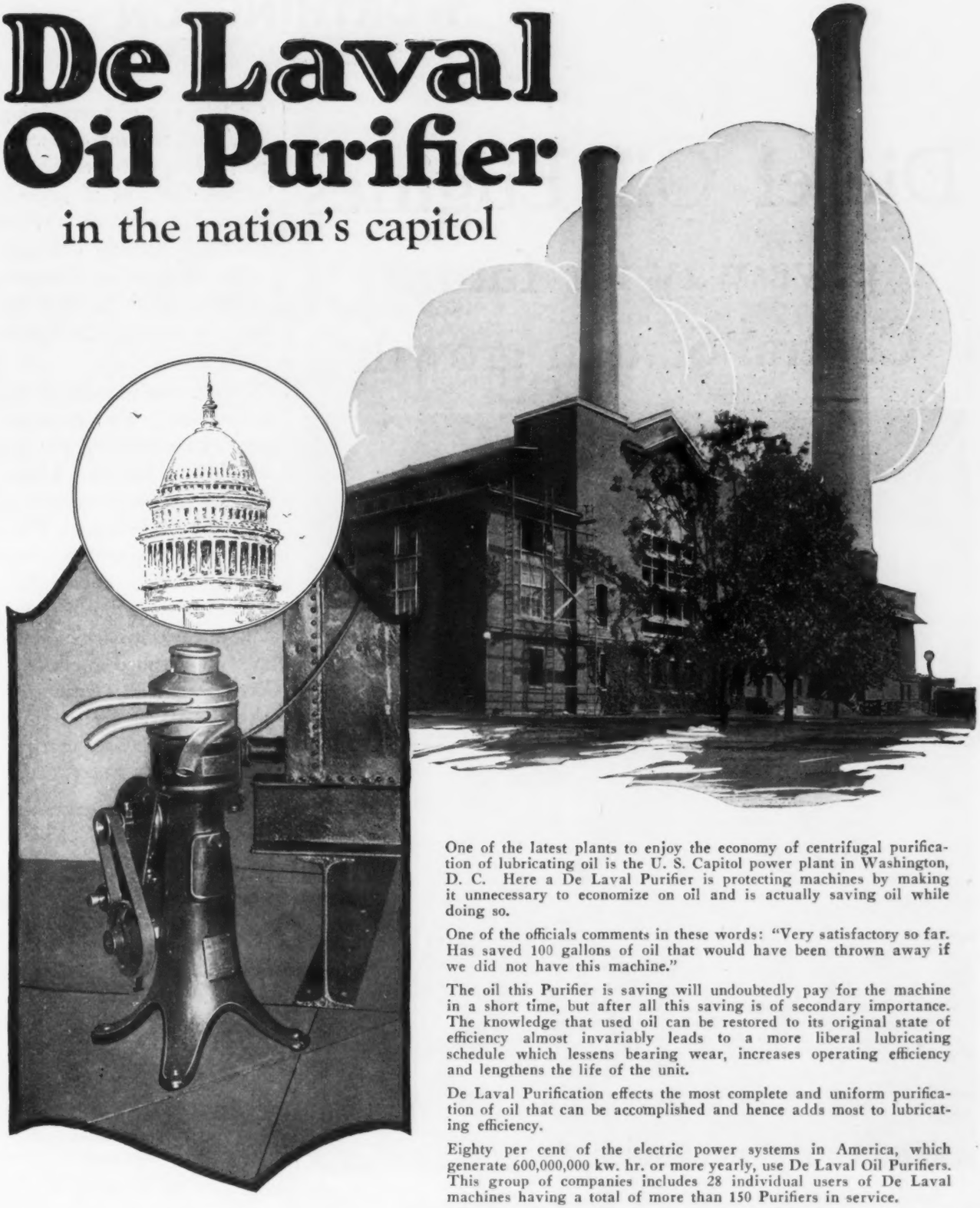
McINTOSH & SEYMOUR
DIESEL ENGINES

De Laval Oil Purifier

in the nation's capitol



This illustration shows the De Laval Oil Purifier in the Capitol power plant at Washington, D. C.

One of the latest plants to enjoy the economy of centrifugal purification of lubricating oil is the U. S. Capitol power plant in Washington, D. C. Here a De Laval Purifier is protecting machines by making it unnecessary to economize on oil and is actually saving oil while doing so.

One of the officials comments in these words: "Very satisfactory so far. Has saved 100 gallons of oil that would have been thrown away if we did not have this machine."

The oil this Purifier is saving will undoubtedly pay for the machine in a short time, but after all this saving is of secondary importance. The knowledge that used oil can be restored to its original state of efficiency almost invariably leads to a more liberal lubricating schedule which lessens bearing wear, increases operating efficiency and lengthens the life of the unit.

De Laval Purification effects the most complete and uniform purification of oil that can be accomplished and hence adds most to lubricating efficiency.

Eighty per cent of the electric power systems in America, which generate 600,000,000 kw. hr. or more yearly, use De Laval Oil Purifiers. This group of companies includes 28 individual users of De Laval machines having a total of more than 150 Purifiers in service.

The De Laval Engineering Department will be glad to cooperate with you in order that you may have the same kind of lubricating and transformer oil which helps keep America's greatest power systems operating so smoothly. We have interesting proof of the savings in wear on machinery and in oil and labor that can be made.

THE DE LAVAL SEPARATOR COMPANY

New York, 165 Broadway 600 Jackson Blvd., Chicago

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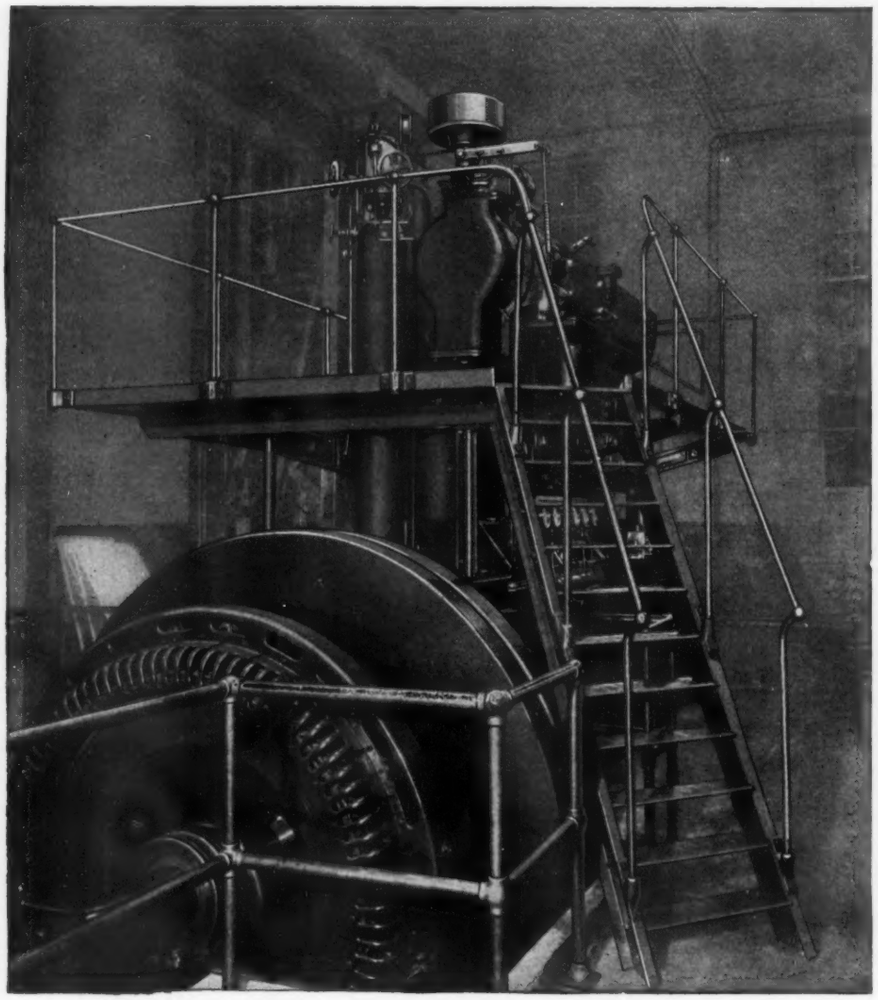
WORTHINGTON

Diesel Oil Engines

pave way for future Central Station growth



One of three Worthington 300 hp. air-injection Diesel Oil Engines in use by large Oklahoma electric power company to meet load requirements of a small city until volume of business warrants extension of transmission lines.

THE cost of transmitting small amounts of electric power long distances may far exceed the cost of generation. Yet central station growth frequently demands extension of service to remote localities which in time are sure to represent profitable load.

Where such conditions are encountered, the excessive cost of transmitting can be avoided by installing Diesel Oil Engine generator sets in the locality to be served. Thus load requirements are met with immediate profit. Later, if the volume of business justifies it, the transmission lines may be extended to take the load and the Diesel can then be used either for stand-by or transferred to another locality.

Among the features of the Diesel Oil Engine which have led to its adoption by a number of central stations for the generation of small amounts of power to serve remote localities and for stand-by service in main power stations are the following:—

1. Unfailing service
2. No stand-by fuel losses
3. Close speed regulation permitting operation of alternators in parallel
4. Low fuel consumption

No other American Company is in so favorable a position to furnish Diesel Oil Engines of all sizes as Worthington. Inquiries regarding engines of from 50 hp. to 12,000 hp. are invited.

Pumps
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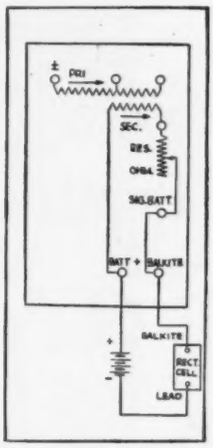
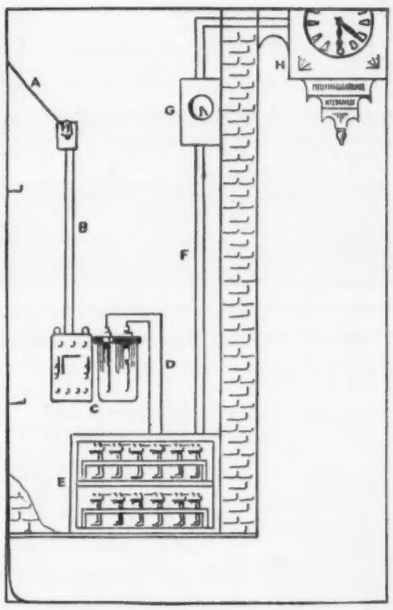


Balkite

Trickle Charging for Instrument Operation



[A] *Alternating Current Line.* [B] *Alternating Current to Balkite Charger.* [C] *Balkite Charger.* [D] *Direct Current to Battery.* [E] *Battery.* [F] *Direct Current to Clock Operating Mechanism.* [G] *Clock Operating Mechanism.* [H] *Outdoor Clock.*

A Balkite Trickle Charge Clock System

In Balkite Trickle Charging a Balkite Charger is permanently connected to an AC source and rectifies the AC into DC. It charges a battery continuously. The DC current from the battery operates the apparatus. In case of temporary failure of the AC line the battery has stored in it enough energy to operate the apparatus alone. The sketch above shows a typical installation for a clock. The principles of the system are the same in its application to other types of work.

Our recent booklet, "The AC Floating Battery System," completely describes the charger, its operation, advantages and applications. A copy will be sent on request. Write for it.

Certain instruments such as pyrometers, flue gas meters, CO_2 recorders, require constant voltage for their accurate operation. This constant voltage can best be obtained by the use of a small storage battery charged by the Balkite Trickle Charge System.

In this system a Balkite Charger is connected to the regular power line and allowed to charge a storage battery continuously at a low rate. It thus automatically keeps the battery fully charged at all times. The reserve power always available in the storage battery insures operation even in case of failure in the power line. Failure to operate for want of power is entirely removed.

The diagram above shows an installation of the system for instrument operation. Balkite Chargers are particularly suited to this type of work because of their dependability. They require practically no attention, have no moving parts, nothing to break, adjust or get out of order.

These advantages also make Balkite Trickle Charging ideal for Railway Signaling, for which it has already been adopted by 85 Railroads, Telegraph Work, Time Recording Systems, Fire and Burglar Alarm Systems, Emergency Lighting—wherever unfailing power is required.

FANSTEEL PRODUCTS COMPANY, INC.
North Chicago, Illinois

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BMA

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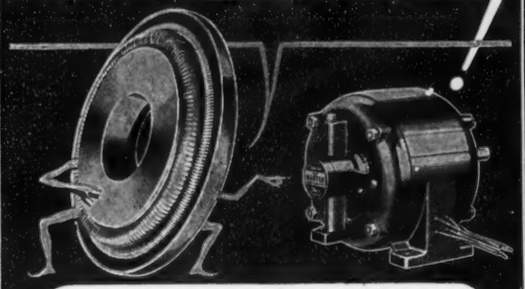


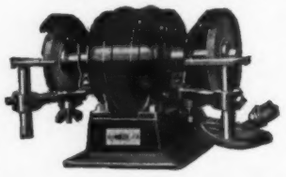
"Yes, sir, I'm the Patented Automatic, Fool-Proof Starting Device found on MASTER GUARANTEED MOTORS. *I guarantee more than one million starts.* This is equivalent to *one hundred years of uninterrupted service* at an average of twenty-seven starts per day."

THE MASTER ELECTRIC COMPANY
Linden & Master Aves. Dayton, Ohio

STOCKS CARRIED IN PRINCIPAL CITIES
MASTER GUARANTEED MOTORS
⅛ TO 7½ H.P. Dayton THE MASTER ELECTRIC CO. Ohio Less than 40°

COMPETITION—

Makes Efficient Tools a Necessity and the Sharpest Tools Are the Most Efficient



THE BODINE
Portable Electric
TOOL GRINDER

is the one machine which has correctly solved the problem of keeping tools sharp.

THE BODINE isn't "just a grinder." It is a highly specialized tool for increasing profits by increasing production. It makes it so easy to keep the cutting edges of tools at maximum efficiency.

Write for a copy of "Eight Outstanding Advantages"

BODINE ELECTRIC COMPANY
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O-Z Hand Tachometers
Speeds at a glance. No timing
"Dead Beat" Accurate
30-24,000 R.P.M.

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Draws graphic charts of speeds.

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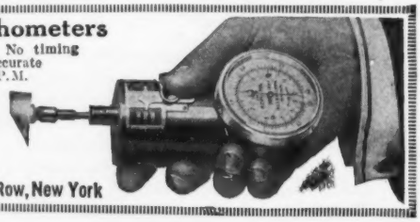

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Standard of the World
HAND AND MOTOR OPERATED
14 Sizes of Machines
What it costs to bend pipe our way. Per Bend:
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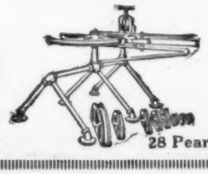
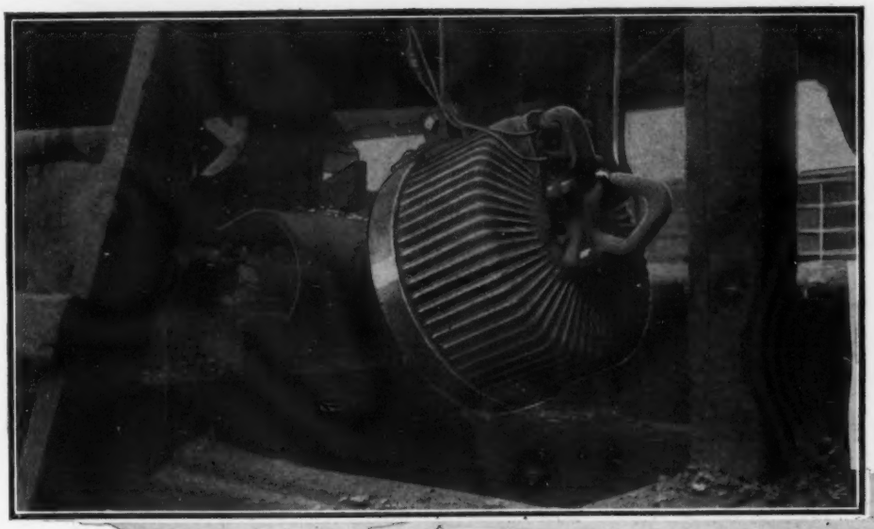
2-in. pipe, 10 cents 6-in. pipe, 60 cents
8-in. pipe, $1.00



Send for Catalogue
American Pipe Bending Machine Co.
28 Pearl St., Boston, Mass. *One Year to Pay*



TRAMP IRON

Almost every industry using raw materials has some point in its processes at which tramp iron in these materials can cause untold damage and delay.

In the cement mill it is at the crushing rolls; in the glass plant the finished product may be worthless; in the grain elevator where grinders are preparing feed, a tiny piece of steel may strike a spark that will wreck the plant; a bolt may fall from the slab slasher in a saw mill and go with the waste timber to the hog which chews up that waste for fuel, with the result that a blade is broken and the fuel system is tied up; as ore comes from the mine, it may contain a broken tool which, if not taken out, gets into the crusher and breaks a roll.

These are not only possibilities but typical examples of just what does happen far too frequently in industries similar to these. EC&M Separator Magnets are installed to prevent such accidents.

EC&M Separator Magnets perform efficiently and continuously with no cost whatever for maintenance. As there are no moving or rotating parts, sliding contracts or collector rings, EC&M Separator Magnets require no attention after they have been installed.

Send for our illustrated Separator Magnet leaflet

THE ELECTRIC CONTROLLER & MFG. CO.

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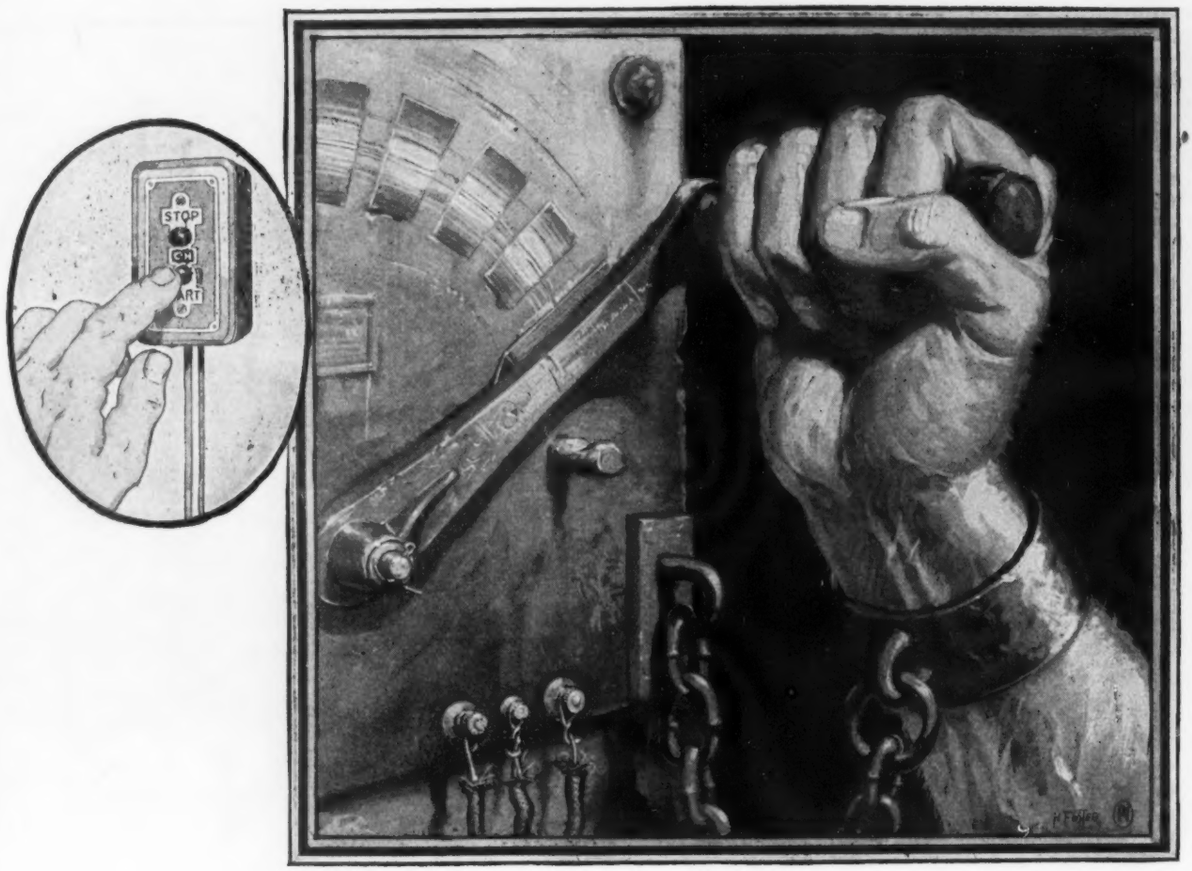
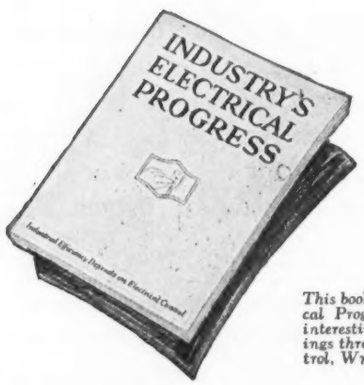
SAN FRANCISCO-CALL BUILDING
SEATTLE-570 COLMAN BLDG.
TORONTO-TRADERS BANK BLDG.



The trend of industry is decidedly toward Cutler-Hammer Push Button Control. Merely a touch of the proper button right at the machine starts, accelerates, decelerates, regulates the speed or stops the motor as required. The controller is placed in any safe, convenient location. Saves time, affords better control and provides greater safety—a logical step in advance.



This booklet "Industry's Electrical Progress" puts into concise, interesting form the story of savings through modern motor control. Write for your copy today.

C-H

CUTLER

Industrial Efficiency

Industry cannot afford this penalty!

Obsolete motor control takes a staggering toll from many so-called modern plants

ARE labor costs high?

Decidedly so in the plants where labor is shackled to obsolete equipment! It is an overwhelming handicap in the face of competitive conditions today.

This is especially true in the case of motor control equipment. For modern motor control saves where saving counts the most—in the wasted time of labor. And labor cost in practically every industry is usually the major item of manufacturing expense.

Too, it has been easy for plants to fall behind the progress made in the perfection of motor control. Paralleling the increased use of electric power in industry, this progress has been swift and tremendous. Since 1905 the electricity used for industrial power has increased 3000%. In the last ten years alone, it has multiplied by six.

Has industry's electrical progress left your plant behind?

Cutler-Hammer engineers have steadily kept motor control equipment abreast of industry's demands. And each new application—each new problem solved has proved a step nearer maximum economy in production.

Industrial executives today realize that it is high time to determine where their equipment stands in this race for lowest costs. The use of motors is practically universal in industry. Their advantage now lies in the labor saving obtained through their proper control.

Someone in your plant ***must*** investigate! To add to profits now through economies in production gives any plant an advantage in competition. To wait only postpones progress.

Call in the Cutler-Hammer field engineers! They will gladly counsel with your plant men or consulting engineers in making a survey of your motors to point out places where modern control will reduce costs. Their recommendations are based on control experience as old as motors themselves.

Demand the C-H trademark on the equipment you buy in which motor control is incorporated as an integral part. In the planning of any new drives, remember that motors by themselves are only brute force. The savings they produce depends on the effectiveness of their control.

The CUTLER-HAMMER Mfg. Co.

Pioneer Manufacturers of Electric Control Apparatus

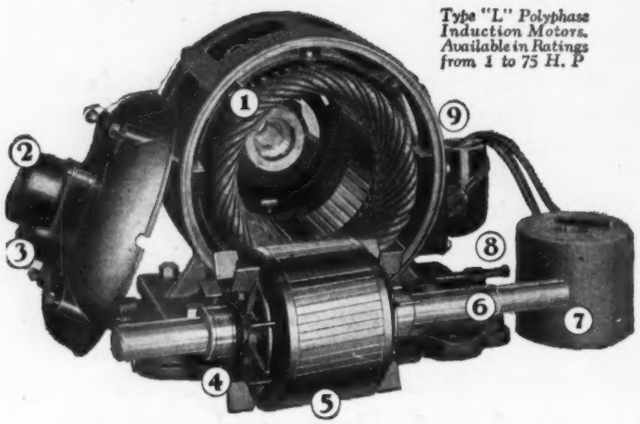
1212 St. Paul Ave.

MILWAUKEE, WIS.

HAMMER

Depends on Electrical Control

A "Little" BETTER at 9 vital points



Type "L" Polyphase Induction Motors. Available in Ratings from 1 to 75 H. P

LONG, trouble-free service life has been engineered into Robbins & Myers Motors by the simple process of building them *just a little better than usual at every vital point.* Costs us (not you) somewhat more. But it's satisfaction-insurance.

1 Pre-treated wire used in the winding; coils easily repaired or replaced

2 Dust-proof ring oiling bearings carried by substantial end heads

3 Large oil reservoir with spring hinged cover, drain plug and overflow

4 Two fans assure thorough ventilation

5 Rotor well balanced; note large shaft and general rugged design

6 Bearing surfaces are accurately ground

7 Paper pulley insures minimum slip, therefore longer belt life

8 Simple adjustment of belt tension. One screw on each end of sliding base

9 Conduit terminal box can be turned up or down or to either side; separable cover gives quick acccess to connections.

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Buffalo, 831 Ellicott Sq. Bldg.
Philadelphia, 1418 Walnut St.
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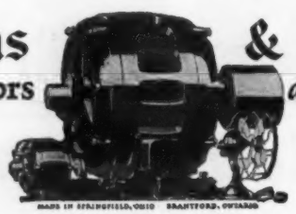
Robbins & Myers Motors and Fans



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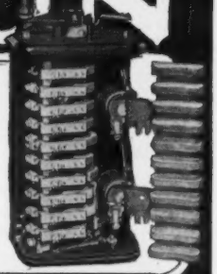

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Milwaukee, Wis. 20 Sales and Service Offices

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Oil Immersed
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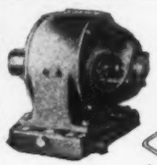
Industrial Controller Co.
Milwaukee, Wis.



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D. C. and A. C., Ball Bearing Motors of the medium commercial sizes. D. C. machines up to 75 HP. with Commutating Poles. Get Bulletin No. 200.

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Special machines built to meet your needs. Full details cheerfully supplied. Write

Marble-Card Electric Company
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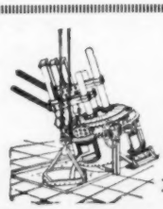

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Most Rapid and efficient for making
Tool Steels, Alloy Steels, Forging Steels
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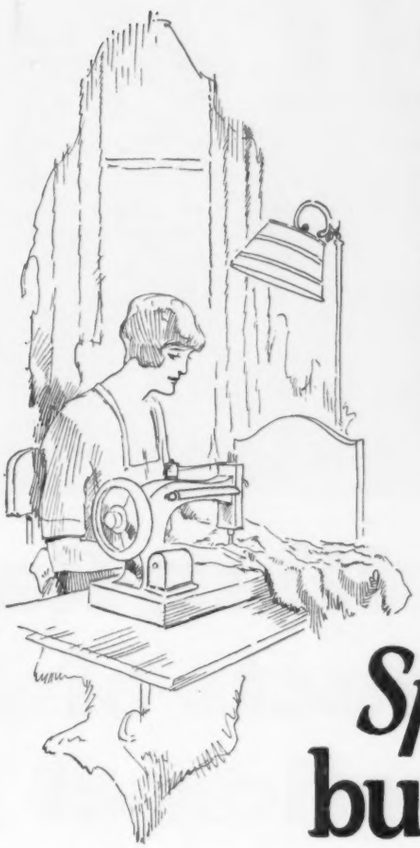
Repetition is Reputation



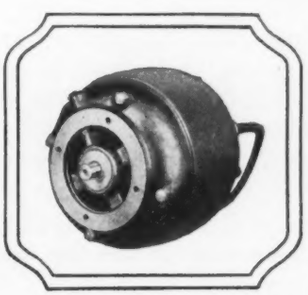
Special Engineering but no Price Penalty

The reasons why Domestic *special* motors are "abreast the rest" in price are clear and simple.

Special motors, built in the few types most widely applicable to the fractional horsepower field, are a routine production proposition with us. Domestic Electric research, sales, production and service departments are organized for this business only. Every motor order is followed through as an individual unit from the time the first contact with the purchaser is established until the finished motors are in operation.

Yet the advantages of this individual service are not reflected in the cost of motors to either the appliance manufacturer or the consumer. The Domestic Electric Company is organized and operated to produce *special* motors as other manufacturers produce *stock* motors. Factory equipment was designed and developed in the Domestic plant to build according to Domestic methods. Short-cuts and economies of production are thus made possible that could not be effected under any other policy.

If you have a problem in the application of motors to household, commercial or industrial appliances, call upon our engineers for this service. New economies and greater efficiency, such as have resulted in other fields, are yours for the asking.

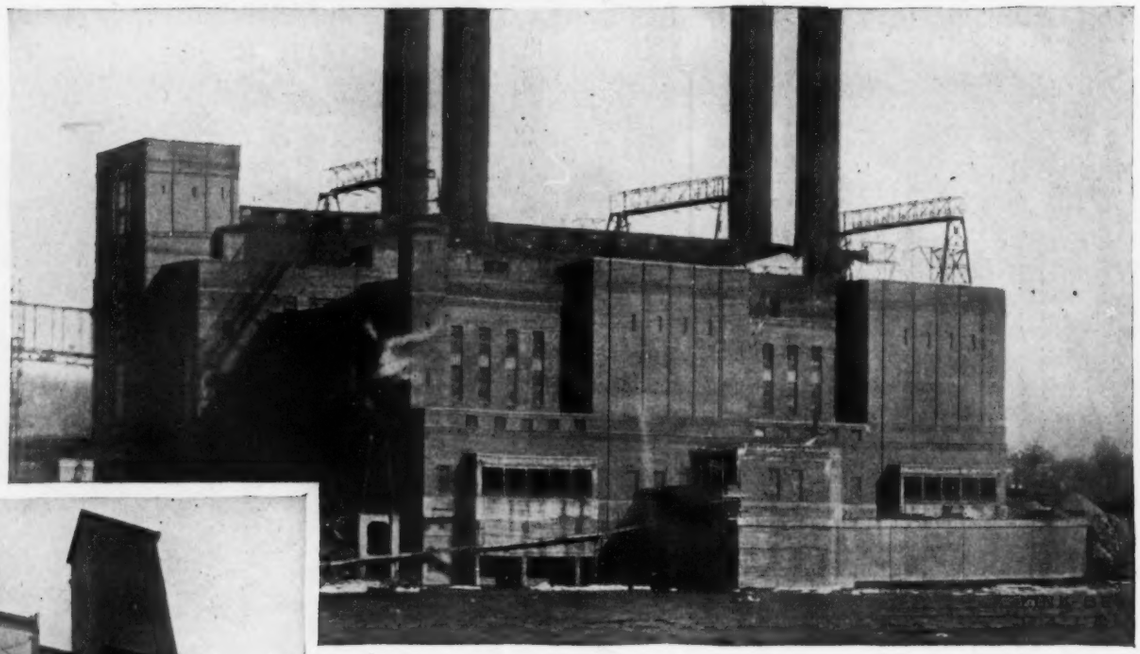


THE DOMESTIC ELECTRIC COMPANY
7209-25 St. Clair Ave. CLEVELAND, OHIO

Manufacturers of fractional horsepower motors exclusively

(79)

Domestic Electric Motors



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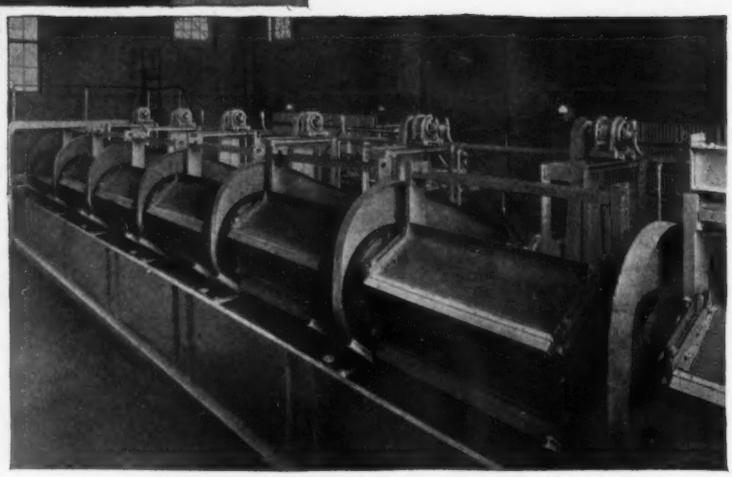
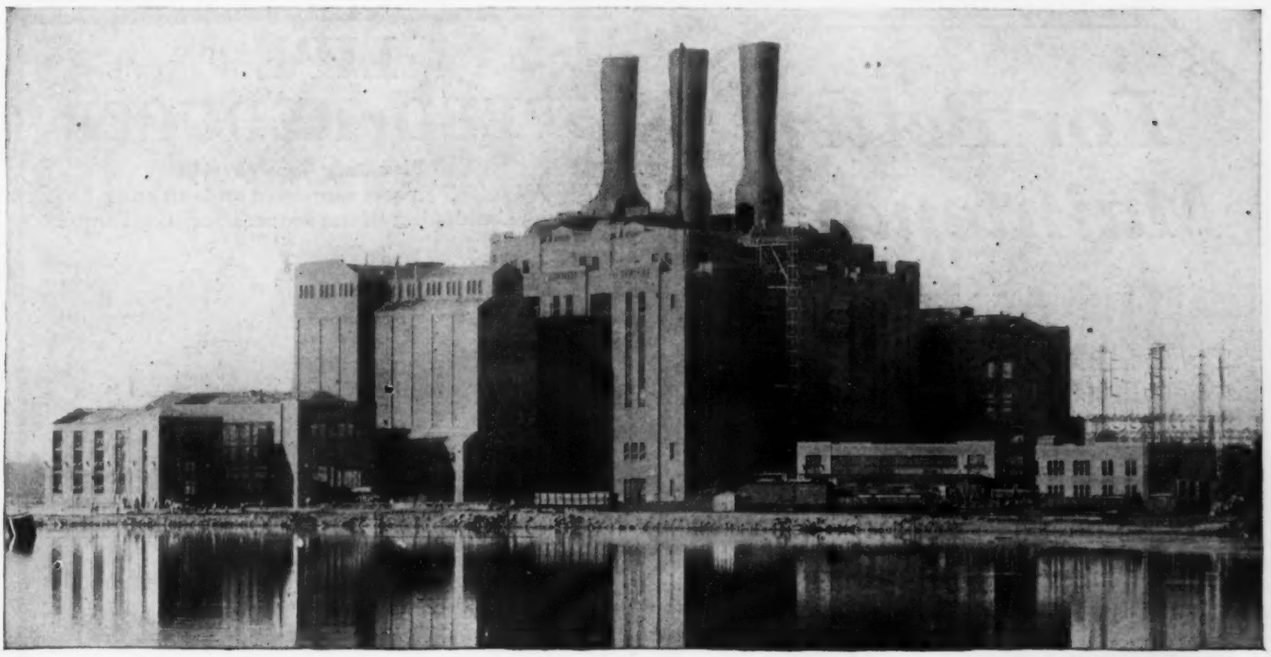


LINK-BELT experience in the design and manufacture of all types of conveying machinery includes installations in hundreds of power plants.

Link-Belt manufactures complete, in its own plants, every type of conveying equipment that has stood the test of efficient, practical operation, and that has received the approval of the engineering profession generally.

LINK-BELT



w Materials and Waste
o wer—an economical
.i nk-Belt equipment

From this advantageous position, the designs by Link-Belt Engineers are made without prejudice as to type of equipment, and with the sole thought of supplying our customers with what our accumulated experience indicates will best and most economically meet their requirements.

The quality and service of Link-Belt equipment is universally recognized. It can be depended on to give continuous operation, with a minimum maintenance expense.

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For grinding and polishing commutators while running. Fast cutting, slow wearing. Every stone tested and guaranteed.

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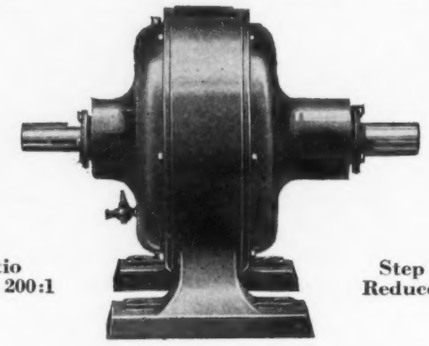
LIPE SPEED REDUCER

Full Planetary Construction
All rotating parts supported on both ends
Torque Cushioning Device reduces Starting Torque



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¼ to 5 H. P.

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Superior 1 to 5 H.P. motors, D.C. or A.C., built on a sectionalized plan. Can be used for special applications without excessive developing cost. *Write for Bulletin.*

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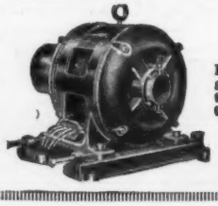

STAR
Ball Bearing Motors

Direct and Alternating Current up to 75 hp. Also generators and alternators in horizontal and vertical types, and motor generator sets. We build motors to meet your requirements. *Ask for more data.*

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Motor Ability

is Limited by

Bearing Ability

A motor can stand what its bearings will stand—and no more. It will last as long as its bearings—and no longer.

With **"Norma"** Precision Ball Bearings in successful month-after-month operation at speeds up to 50,000 R.P.M.—

And with **"Hoffmann"** Precision Roller Bearings standing up month after month at speeds up to 20,000 R.P.M.—

Need you look further for an answer to the question *"what are the bearings to use for dependable motor service?"*

Because—obviously—a bearing that is safe at these super-speeds, has a still higher factor of safety at the usual motor speeds.

Ask our engineers for more data—or write for catalogs 904, 905 and 915.

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Anable Avenue Long Island City New York

PRECISION BALL, ROLLER AND THRUST BEARINGS

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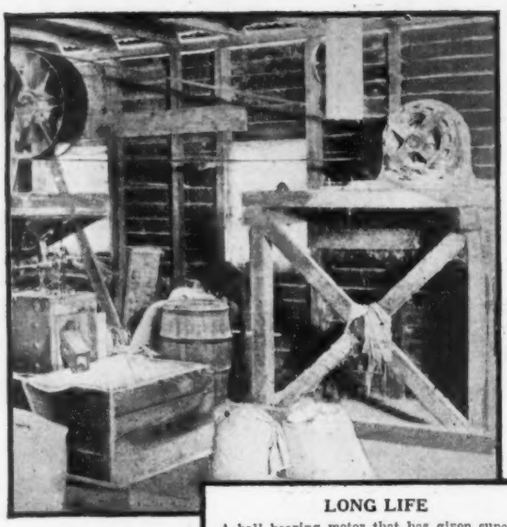
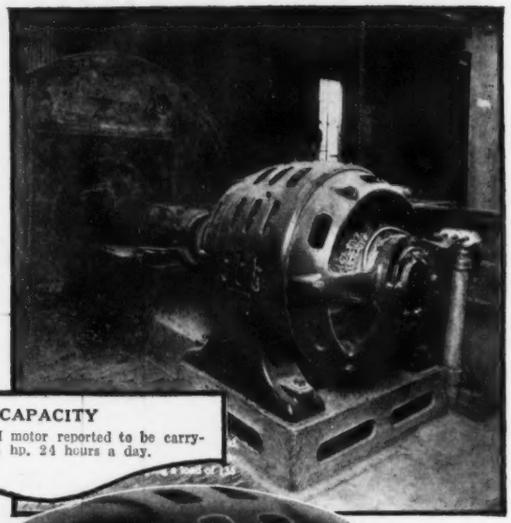
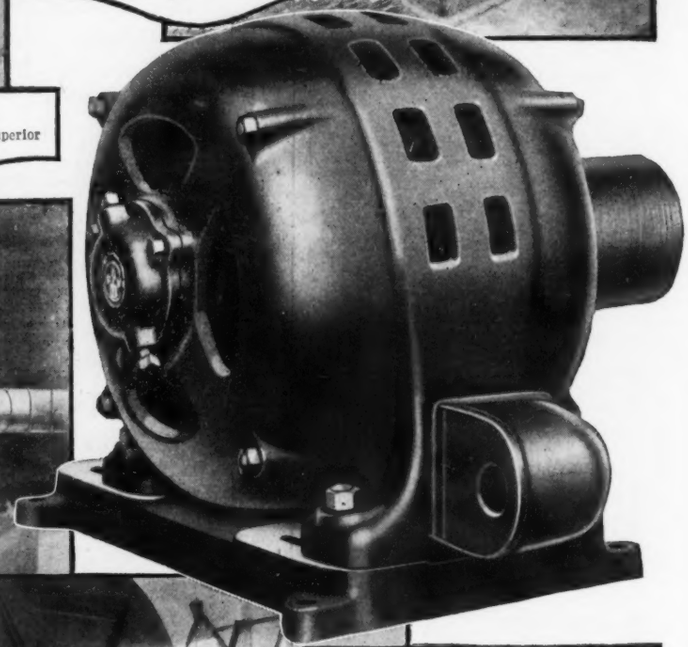


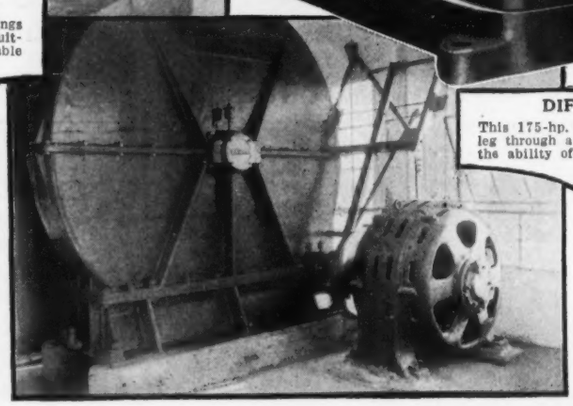


CAPACITY
A 100-hp. F-M motor reported to be carrying 135 hp. 24 hours a day.

LONG LIFE
A ball bearing motor that has given superior service since 1914.

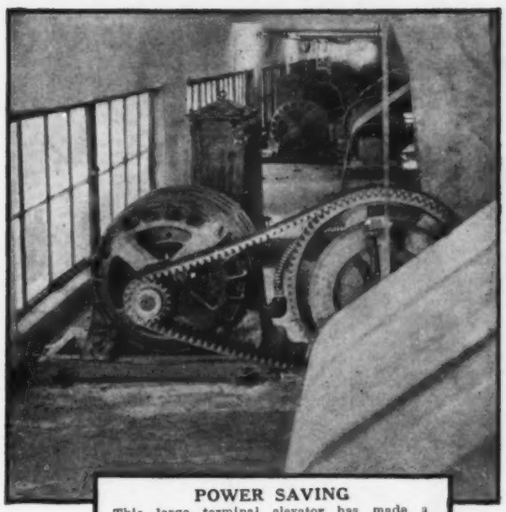


SAFETY
The sealed ball bearings and liberal ratings of F-M motors make them especially suitable for use in the presence of inflammable dust or explosive vapor.

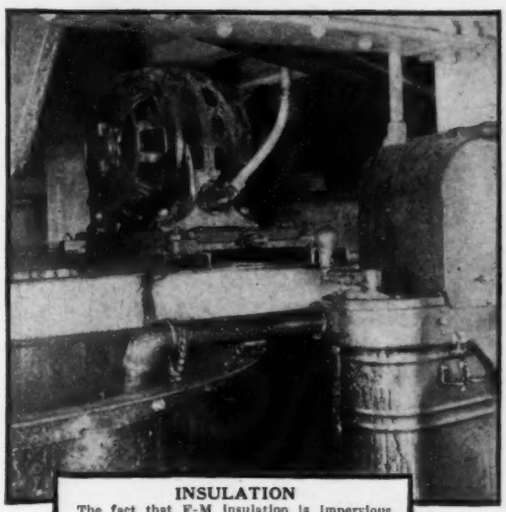


DIFFICULT DRIVES
This 175-hp. F-M motor driving an elevator leg through a clutch and gear drive, typifies the ability of F-M motors to *stay put*.

FAIRBANKS-MORSE



POWER SAVING
This large terminal elevator has made a decided power saving by standardizing on F-M ball-bearing motors.



INSULATION
The fact that F-M insulation is impervious to oil and moisture is well brought out by this installation where insulation is continually soaked in oil.

Giving more than ordinary service

The conditions for which you select motors may not tax their quality to the extreme degree. But, after all, there is a real feeling of security in specifying a motor that has proved equal to unusual demands.

You will be interested in the booklet covering Fairbanks-Morse motors in all kinds of service. Its purpose is to show that Fairbanks-Morse motors are giving users more than they ordinarily expect of a good motor.

FAIRBANKS, MORSE & CO., Chicago
Manufacturers of Electrical Machinery, Pumps, and Oil Engines
28 Branches throughout the United States at your service

Pioneer Manufacturers of

ball bearing motors

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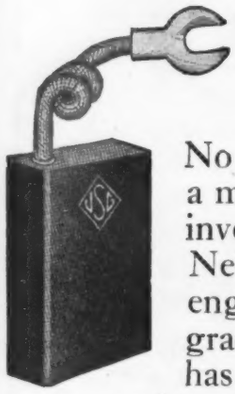

Prescription Blanks

No doctor recommends a medicine until he has investigated conditions. Neither does the U. S. G. engineer recommend the grade of brush until he has information on the motor and conditions under which it is to be used.

For this reason it is necessary to have your load and service information before fitting brushes to a motor. Then when U. S. G. Brushes are installed they are guaranteed to give you the best possible service. Try this specialized service on one of your troublesome motors. It costs you nothing. Write now.

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The United States Graphite Co.
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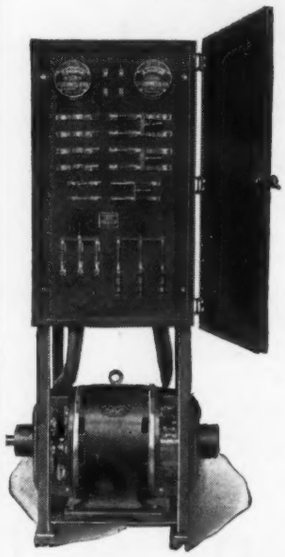
Why Buy a
MOTOR GENERATOR SET
When a
MARTIN ROTARY
Does the Work?



10% Better Efficiency and 100% Power Factor

Sizes 1½ KW. to 50 KW. with control panel. To convert from any voltage A.C. to any desired voltage D.C.

For { Industrial Purposes / Battery Charging / Motion Pictures

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Baldor Electric Motors
Ball Bearing

Single Phase Repulsion Type
Direct Current
Polyphase

Horizontal and Vertical Design.
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Superior in Quality. Competitive in Price.

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Brass, Steel and Copper Washers.
Flat, Bevelled or Countersunk.
Special Sizes and Shapes.
Prompt Deliveries. Let us have your inquiry.
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WARD LEONARD RESISTOR UNITS

can be furnished mounted in dozens of ways: with Edison base; with variable taps; with base to fit UX or any other socket, and in any value from 1 ohm to 1,000,000 ohms.

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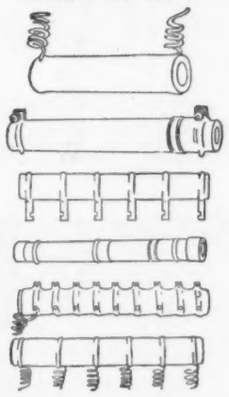
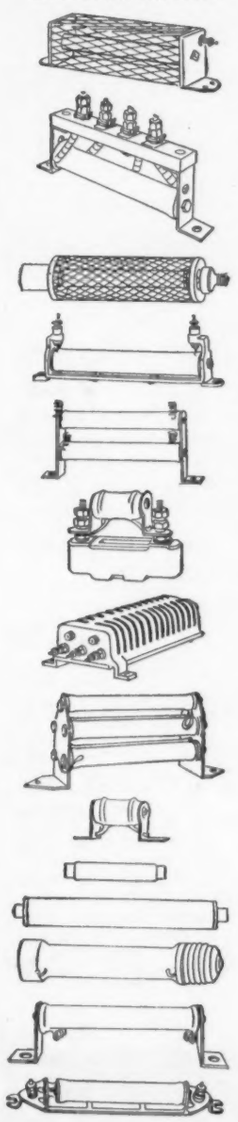


MOUNTINGS



Hats off

to young Radio Experimenters

Unhampered by old taboos—not caring what traditions said "couldn't be done"—men with real ideas made radio the wonder that it is. But the resourceful searching of radio electrical engineers confirms one conclusion that industrial electrical engineers reached years ago:

Only a properly processed and protected wire-wound resistor remains accurate

In attempts to squeeze resistance into too-small-space at lower-than-possible-cost, experimenters have tried everything from typewriter carbon paper to winding their own. All have one fault; the resistance values change with age and use, upsetting careful calculations. Only a wire-wound resistance has possibilities of having fixed, unchanging value.

Ward Leonard wire-wound resistors—the standard of the electrical industry—have been developed down to minimum size and up to an unchanging exactness in values. Ward Leonard resistors are not affected by age, abrasion, oxidation, or the vagaries of weather. When necessary, wire for these resistors is drawn down to the thinness of the finest human hair, then wound on a small porcelain tube. The wire is covered with a vitreous enamel that permanently protects the resistance against electrical, mechanical or chemical disintegration.

(As R.C.A. uses Ward Leonard resistance. Mounted to fit standard UX sockets)

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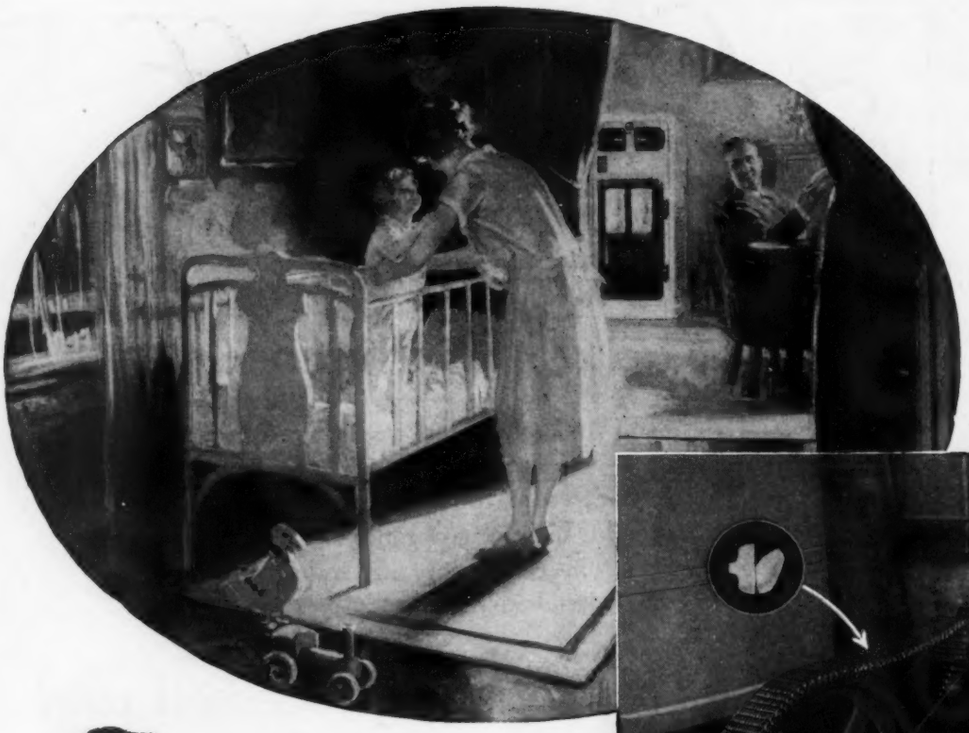
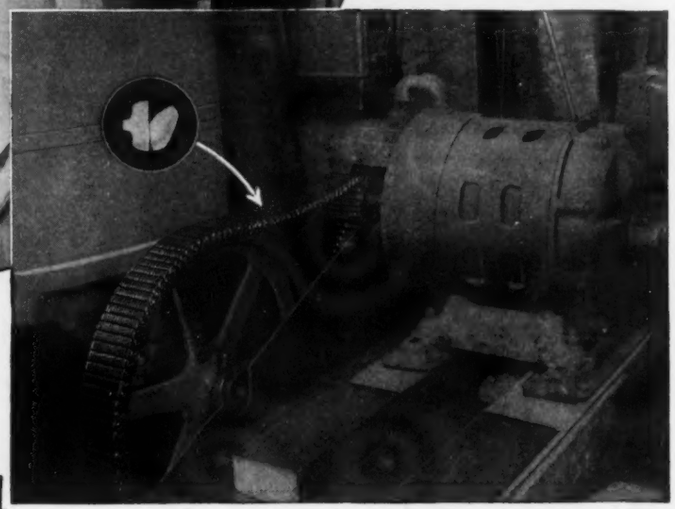
Ward Leonard Electric Company

37-41 South Street Mount Vernon, N. Y.



20 H.P. Morse Silent Chain Drive from motor to sand mixer, American Radiator Co., Buffalo, N. Y. Driver, 725 r.p.m.; Driven, 112 r.p.m., 36 inch centers.



Producing Ideal Boilers and AMERICAN RADIATORS

IDEAL BOILERS and American Radiators economically provide heat and make many homes warm and comfortable. Back of this well-known line of heat producers, there must necessarily be efficient manufacturing processes and dependable equipment.

At the plant of the American Radiator Co., Morse Silent Chain Drives contribute to dependable and low-cost production by keeping machines in continuous operation. Their sustained efficiency of 98.6%, their flexibility and positive action—these and numerous other features are helping to solve production problems for many nationally known concerns.

Over 6,000,000 H.P. in use, one tenth to 5,000 H.P., 6,000 to 250 r.p.m. and slower. The nearest Morse Transmission Engineer is always available.

MORSE CHAIN CO., ITHACA, N. Y., U. S. A.

Morse Engineers are always available at:

ATLANTA, GA.....702 Candler Bldg. Earl F. Scott & Co.
BALTIMORE, MD.....1002 Lexington Bldg.
BIRMINGHAM, ALA...Moore Handley Hdwe. Co.
BOSTON, MASS.....141 Milk St.
BUFFALO, N. Y.....Ellicott Square Bldg.
CHARLOTTE, N. C..404 Commercial Bank Bldg.
CHICAGO, ILL.....112 W. Adams St.
CLEVELAND, OHIO.....421 Engineers Bldg.
DENVER, COLO.....211 Ideal Bldg.
DETROIT, MICH.....7601 Central Ave.
LOUISVILLE, KY., 516 W. Main St. E. D. Morton Co.
MINNEAPOLIS, MINN., 413 Third St. Strong-Scott Mfg. Co.
NEW ORLEANS, LA., Queen & Crescent Bldg., 334 Camp St. A. M. Lockett & Co., Ltd.
NEW YORK, N. Y.....50 Church St.
OMAHA, NEB.....727 W. O. W. Bldg., D. H. Braymer Equipt. Co.
PHILADELPHIA, PA....803 Peoples Bank Bldg.
PITTSBURGH, PA.....Westinghouse Bldg.
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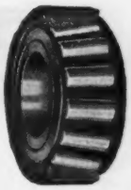
ST. LOUIS, MO....2137 Railway Exchange Bldg.
TORONTO, 2, ONT., CAN., 50 Front St. E. Strong-Scott Mfg. Co.
WINNIPEG, MAN., CAN., Dufferin St., Strong-Scott Mfg. Co.

1240



The Red Band and Timkens Distinguish Howell Motors

To all their distinctive features of design, and to their distinctive red-band identification, Howell motors add the equally great distinction of using Timken Tapered Roller Bearings.

Timken-equipped Howell motors can run for life without any bearing attention except lubrication a very few times a year under worst conditions! Clearance is always perfect. Starting is quicker, and running is cheaper, since needless friction is gone. Greater rigidity and compactness improve Howell drives. Thrust and shock are carried equally well with radial load in Timken-equipped Howell motors.

By the use of Timken Tapered Roller Bearings Howell provides all the latest economies in electric motor usage.

THE TIMKEN ROLLER BEARING CO.
CANTON, OHIO

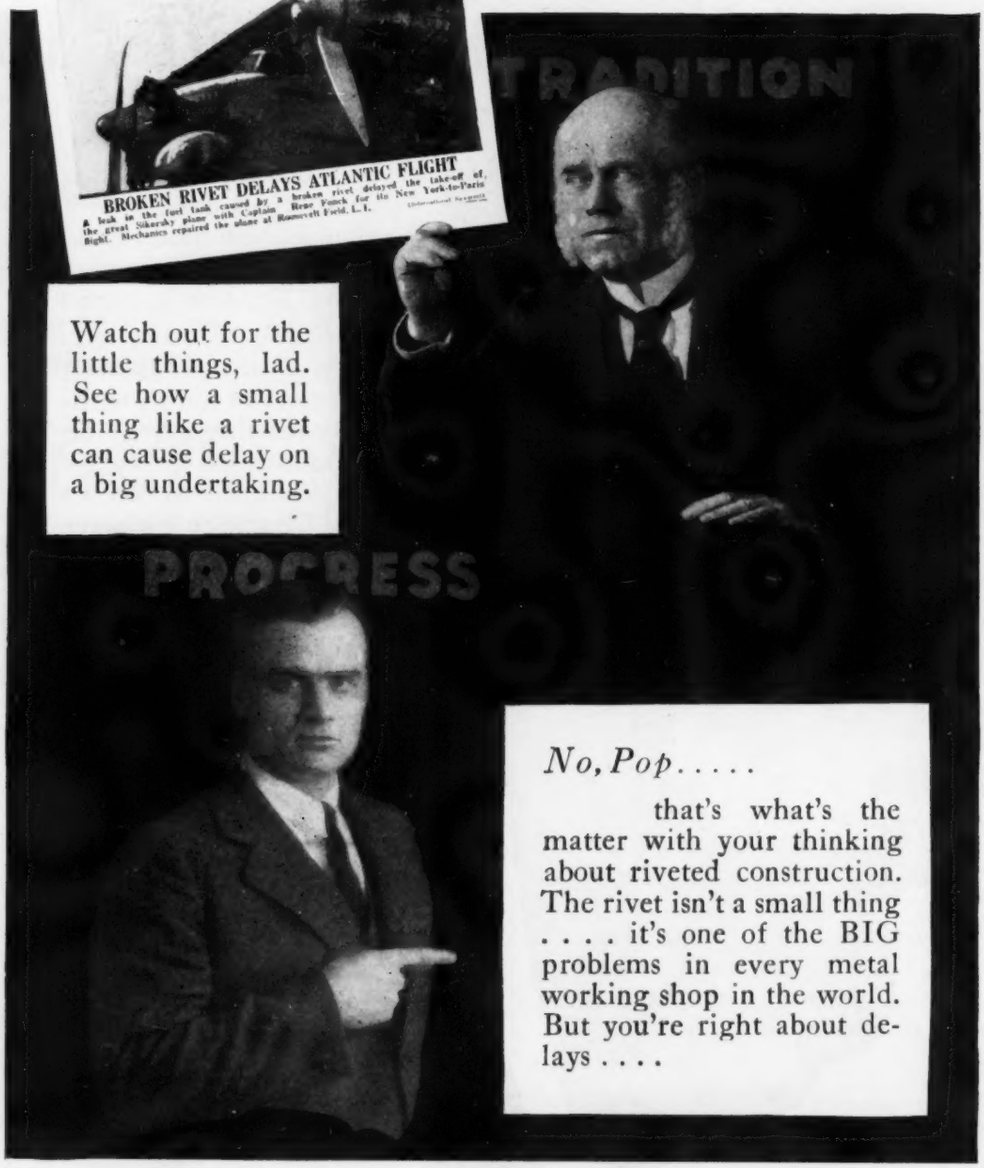
TIMKEN *Tapered Roller* **BEARINGS**

The BETTER way

For want of a rivet....

BROKEN RIVET DELAYS ATLANTIC FLIGHT

A leak in the fuel tank caused by a broken rivet delayed the take-off of the great biker-ship plane with Captain Rene Fonck for the New York-to-Paris flight. Mechanics repaired the plane at Roosevelt Field, L. I.

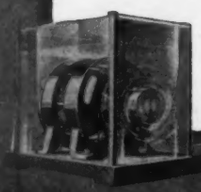


Watch out for the little things, lad. See how a small thing like a rivet can cause delay on a big undertaking.

build (5)—to increase and strengthen: to increase the power and stability of: to settle or establish and preserve:
—*Webster*

No, Pop.....

that's what's the matter with your thinking about riveted construction. The rivet isn't a small thing .... it's one of the BIG problems in every metal working shop in the world. But you're right about delays ....



LINCOLN

IS WELDING—SO

If all the delays caused by rivets in this country's manufacturing program, were laid end to end, 3 score and 10 wouldn't begin to measure the time, and a Rockefeller mind couldn't estimate the money loss to America's industries.

Unless a rivet hole is bored and reamed and the rivet well fitted and made up, it isn't doing the full job for which it was intended.

If it isn't doing its full job. . . .*then it's a makeshift.* So when you're using riveted construction, you have your choice between the makeshift job or the big labor *expense* of a good job.

That's why I'm pleading with you to adopt Stable-Arc welding.

We've got to get our costs down.

Stable-Arc welding will do it, because its cost for a stronger, better joint is low enough to give us the right kind of saving on our machines.

Just get the book on the right and see where our competitors have found the way to lick us on costs.

This book, mailed on request, will answer many questions that come up on the subject of this production tool. The coupon is for your convenience in getting a copy.

This book tells how a product such as the electric motor was placed on a higher plane through Stable-Arc welding. Just check it on the coupon if you desire a copy. By stating your company connections we may be able to send you data applying to your particular business.

The Lincoln Electric Co.

Cleveland, Ohio

"Stable-Arc" WELDER

COUPON

1-9-25

LINCOLN ELECTRIC COMPANY, CLEVELAND

Please send to the address below

....The Motor book

....The Stable-Arc Welder book.

Enclose any data you may have on manufacture of a product such as.....

.....

Name .....

Company .....

Address .....

SPEER BRUSHES

There's one for every service, that will last longer — run more smoothly and give better commutation.

We solicit your inquiries

Speer Carbon Co.

St. Marys, Pa.

Continued from page 234

Tools
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Electric Service Supplies Co.
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Leach Co.
Pneumatic
Ingersoll-Rand Co.
Underground Conduit
Ry. & Industrial Eng. Co.

Torches, Blow
Wall Mfg. Supply Co.

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Milliken Bros. Mfg. Co., Inc.
Riter-Conley Mfg. Co.
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Transmission
Aermotor Co.
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Walker Vehicle Co.
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International Harvester Co.
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Tower
McCardell, J. R.

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Leffel & Co., James
Pelton Water Wheel Co.
Smith Co., S. Morgan
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DeLaval Steam Turbine Co.
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Ridgway Dyn. & Eng. Co.
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Woodward Governor Co.

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Phillips Wire Co.
Roebling's Sons Co., John A.
Rome Wire Co.
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Simplex Wire & Cable Co.
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Steel
Bethlehem Steel Co.
Trolley
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Hazard Mfg. Co.
Rome Wire Co.
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American Brass Co.
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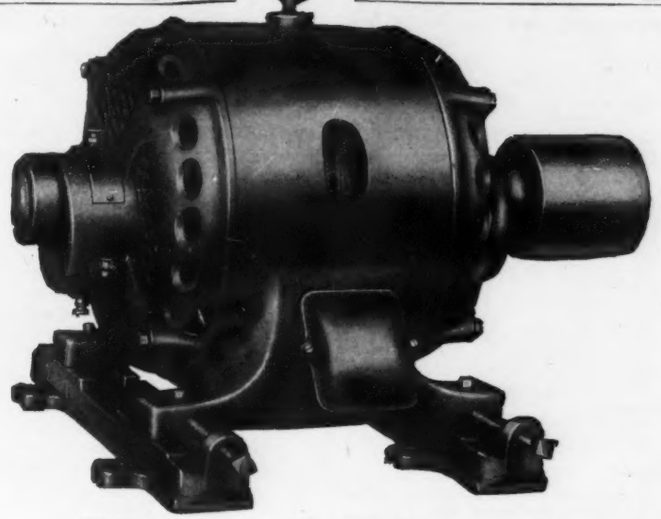
Okonite Company, The
Simplex Wire & Cable Co.

Wireless Apparatus
General Electric Co.
Westinghouse E. & M. Co.

Wire Covering Saturant
Tar Products Corp.

"They Keep a-Running"



30 Horse Power Century Automatic-start Induction Polyphase Motor

High Starting Torque

Century Automatic-start Induction Polyphase Motors develop a starting torque not less than 225% of full load torque. Their ability to start heavy dead loads— and then "Keep a-Running" —accounts for their frequent choice in such service as mixing, crushing, pumping and similar applications where the load is hard to start.

Other features of these motors are:

1. Starting current is low and does not exceed 245% of full load current.
2. Fuses which will protect the motor while running and carrying its load are generally of ample capacity to effect a start.
3. Any approved single-throw switch may be used for starting. Nothing else required.
4. Adapted particularly to installations requiring automatic or remote control.

Note: In one horse power and smaller sizes these motors are regularly equipped with the Century ***Wool-yarn*** System of Lubrication. ***Only continuous unbroken strands of pure wool yarn are used*** and at least one year's continuous 24-hour-per-day operation, without re-oiling, is assured. ***There is a difference.***

Built in all standard sizes from ½ to 60 horse power. Temperature rise not more than 40° Centigrade.

CENTURY ELECTRIC COMPANY

1806 Pine St. St. Louis, Mo.

For More Than 23 Years at St. Louis

½ to 60 H.P. Century MOTORS ½ to 60 H.P.

WHAT AND WHERE TO BUY

Equipment, Apparatus and Supplies Advertised in This Issue with Names of Manufacturers

Readers interested in any articles not listed in these pages are cordially invited to inform us of their wants and every effort will be made to put them in touch with the proper manufacturers.

This index is published as a convenience to the reader. Every care is taken to make it accurate, but ELECTRICAL WORLD assumes no responsibility for errors or omissions.

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Matthews Corp., W. N.

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Leeds & Northrup Co.
Roller-Smith Co.

Apparatus, Photometric
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Apparatus, Testing
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Biddle, James G.
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Cochrane Corp.

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Babbitts
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Graybar Electric Co.

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Roller
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Timken Roller Bearing Co.
Thrust
Norma-Hoffman Bearings Corp.
Smith Co., S. Morgan

Bells, Conduit
G. & W. Electric Spec. Co.

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Blowers
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Sturtevant Co., B. F.
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De Laval Steam Turbine Co.
Steam Driven
Terry Steam Turbine Co.

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Edge Moor Iron Co.

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Hubbard & Co.
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Westinghouse E. & M. Co.
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General Electric Co.
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Enclosed Air
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Ground Connection
Johnson, Jr., T. F.
Sherman Mfg. Co., H. B.
Guy
Hubbard & Co.
Matthews Corp., W. N.
Trolley
Ohio Brass Co.

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Conduit, Rigid, Aluminum
Aluminum Co. of America

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Link-Belt Co.

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Rome Wire Co.
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Superheater Co.

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Condit Elecl. Mfg. Corp.
Electric Power Equip. Corp.
General Electric Co.
Roller-Smith Co.
Ry. & Industrial Eng. Co
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Wadsworth Elec. Mfg. Co.
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Cutler-Hammer Mfg. Co.
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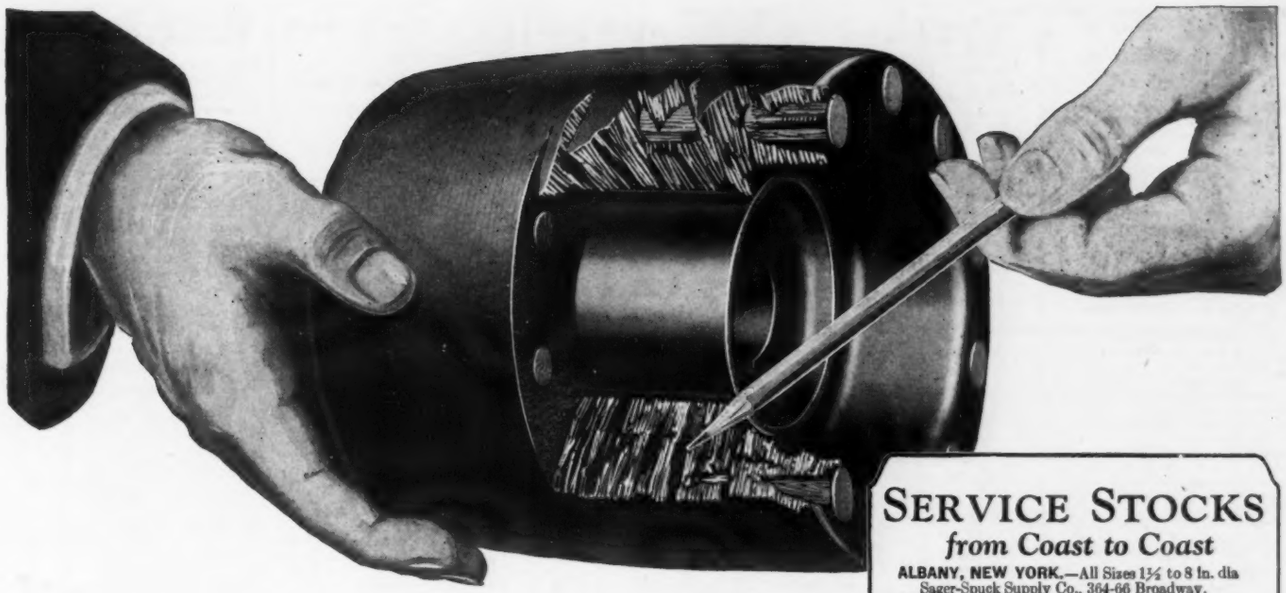
Morse Chain Co.

Dumpers, Freight Car
Wellman-Seaver-Morgan Co.

Dynamometers
Chatillon & Sons, John

Economizers
Babcock & Wilcox Co.
Power Specialty Co.

Electromagnets
Coto-Coil Co.



This End Grain Fibre

Makes Rockwood Paper Pulleys Grip Hardest and Slip Least

Forty years ago— in the early days of power driven machinery, Rockwood conceived the idea of a better belt pulley—a pulley that would transmit more power—*a pulley built of paper!* By compressing layer upon layer of tough, wear-resisting fibre with the end grain exposed as a surface to grip the belt—Rockwood *originated* the paper pulley. Its success was immediate. And today that same pulley—constantly improved through the years—is the accepted standard for electric motors and other high grade belted machinery.

But Rockwood was not satisfied! Innumerable pulley sizes manufactured after receipt of the order and then shipped from the factory necessarily meant slow deliveries. And dealers had to tie up too much money in stock. So 2194 of the more popular sizes in a phenomenal range of 1½ to 14 inch diameters were selected and manufactured in quantities. These 2194 *standardized* pulley sizes were then mobilized in service stocks from coast to coast, each pulley packed ready for instant demand. Now you, Mr. Dealer, can get immediately from a nearby service stock the Rockwood Paper Pulley of the size required. No waiting for the pulley to be made special after the order is received—no waiting for a factory shipment—no stock to carry —no money tied up—no disappointing your customer.

Rockwood Paper Pulleys and Rockwood service have set a standard unapproached by any other pulley manufacturer. You may telegraph, telephone or write for the Rockwood Paper Pulley called for—and in a few hours at most it will be in your hands. Order from the nearest store listed on this page, giving diameter of pulley wanted, width of belt to be used, size of shaft and dimensions of keyway in shaft.

THE ROCKWOOD MANUFACTURING CO., INDIANAPOLIS, U.S.A.

SERVICE STOCKS
from Coast to Coast

ALBANY, NEW YORK.—All Sizes 1½ to 8 In. dia
Sager-Spuck Supply Co., 364-66 Broadway.
ATLANTA, GA.—All Sizes 1½ to 12 in. dia.
Fulton Supply Co., 70 Nelson St.
BALTIMORE, MD.—All Sizes 1½ to 10 In. dia.
Carey Machinery & Sup. Co., 119 E. Lombard St
BIRMINGHAM, ALA.—All Sizes 1½ to 8 in. dia.
Matthews Electric Supply Co
BOSTON, MASS.—All Sizes 1½ to 14 In. dia.
Olmsted-Flint Corp., Cambridge.
BUFFALO, N. Y.—All Sizes 1½ to 10 In. dia.
Root, Neal & Co., 178-180 Main St.
CHICAGO, ILL.—All Sizes 1½ to 14 in. dia.
Chicago Electric Co., 740 W. Van Buren St.
CINCINNATI, OHIO—All Sizes 1½ to 10 in.dia.
Doermann-Roehrer Co., 450 E. Pear l St.
CLEVELAND, OHIO—All Sizes 1½ to 14 In. dia.
Strong, Carlisle & Hammond, 1394 W. Third.
DALLAS, TEXAS—All Sizes 1½ to 14 in. dia.
Southwest General Elec. Co., 1801 N. Lamar.
DENVER, COLO.—All Sizes 1½ to 8 in. dia.
Hendrie & Bolthoff Mfg. and Sup. Co., 1635 17th
DETROIT, MICH.—All Sizes 1½ to 14 in. dia.
Spaulding Electric Co., 1344 Michigan Ave.
INDIANAPOLIS—All Sizes 1½ to 14 in. dia.
Rockwood Paper Pulley Stores, 1801 English.
JACKSONVILLE, FLA.—All Sizes 1½ to 8 In.
Cameron & Barkley Co., 336 E. Bay St.
KANSAS CITY, MO.—All Sizes 1½ to 10 In. dia.
Webb Belting Co., 1501 West Twelfth St.
LOS ANGELES—All Sizes 1½ to 24 In. dia.
Illinois Electric Co., 313 S. San Pedro St.
LOUISVILLE, KY.—All Sizes 1½ to 8 in. dia.
E. D. Morton & Co., Inc., 516 West Main St.
MILWAUKEE, WIS.—All Sizes 1½ to 10 In. dia.
Julius Andrae & Sons Co., Broadway and Mich.
NEW ORLEANS—All Sizes 1½ to 8 in. dia.
Woodward, Wight & Company
NEW YORK CITY—All Sizes 1½ to 14 In. dia.
Rockwood Paper Pulley Stores, 6 Murray St.
OMAHA, NEB.—All Sizes 1½ to 8 In. dia.
Interstate Mchy. & Sup. Co., 1006 Douglas St.
OKLAHOMA CITY, OKLA.—All Sizes 1½ to 8 in. dia.
A. W. White, 424 West Reno St.
PHILADELPHIA, PA.—All Sizes 1½ to 14 In. dia.
Charles Bond Company, 617 Arch St.
PITTSBURGH, PA.—All Sizes 1½ to 12 In. dia.
Transmission & Belting Co., 325 Second Ave.
ROCHESTER, N. Y.—All Sizes 1½ to 8 In. dia.
Rochester Electrical Sup. Co., 240 St. Paul St.
SALT LAKE CITY, UTAH—All Sizes 1½ to 8 In. dia.
Capital Electric Co., 310 W. Second South St.
SAN FRANCISCO—All Sizes 1½ to 20 In. dia.
Bussell Electric Works, 130 8th St.
SEATTLE, WASH.—All Sizes 1½ to 14 In. dia.
Seattle Hardware Co., 501 First Ave. South.
ST. LOUIS, MO.—All Sizes 1½ to 14 In. dia.
Teuscher Pulley & Belting Co., 801 N. 2nd St.
ST. PAUL, MINN.—All Sizes 1½ to 10 In. dia.
St. Paul Electric Co. 145 E. Fifth St.
SYRACUSE, N. Y.—All Sizes 1½ to 8 In. dia.
Syracuse Supply Company, 314 W. Fayette St.
TOLEDO, OHIO—All Sizes 1½ to 8 In. dia.
W. G. Nagel Supply Div., 28 St. Clair St.

The Rockwood Factories at Indianapolis

ROCKWOOD *Instant* PULLEY SERVICE

Enameling Machinery, Wire
American Insulating Machinery Co

Engineering Building and Equipment
Austin Co.

Engineers and Contractors
Ford, Bacon & Davis
Murray, Inc., Thomas E.
White Engr. Corp., J. G.

Engineers, Consulting
(See Directory of Engineers)

Engineers, Transmission Line
Hoosier Engrg. Co.

Engines
Diesel
American Brown Boveri Elec. Corp.
Bethlehem Shipbuilding Corp.
Bethlehem Steel Co.
Busch-Sulzer Bros., Diesel Engine Co.
De La Vergne Machine Co.
Ingersoll-Rand Co.
Lombard Governor Co.
Worthingtin Pump & Machy. Corp.
Internal Combustion
Allis-Chalmers Mfg. Co.
Fairbanks, Morse & Co.
McIntosh & Seymour Corp.
Oil
Busch-Sulzer Bros., Diesel Engine Co.
De La Vergne Machine Co.
Ingersoll-Rand Co.
Lombard Governor Co.
Steam
Allis-Chalmers Mfg. Co.
American Brown Boveri Elec. Corp.
Elec'l Development & Machine Co.
Ridgway Dyn. & Eng. Co.
Unaflow
Ridgway Dynamo & Eng. Co.

Equipment High Tension
Line Material Co.

Equipment, Underground
Line Material Co.

Erectors, Transmission Line
Hoosier Engrg. Co.

Evaporators, Water
Bethlehem Shipbldg. Corp., Ltd.

Exchangers, Heat
Superheater Co.
Griscom-Russell Co., The

Fan Motors
Century Elec. Co.
General Electric Co.
Graybar Electric Co.
Robbins & Myers Co.
Westinghouse E. & M. Co.

Fans (Exhaust and Ventilating)
Buffalo Forge Co.
Century Electric Co.
Robbins & Myers Co.
Westinghouse E. & M. Co.

Fans, Stoker
Buffalo Forge Co.

Fans, Turbine Driven
Terry Steam Turbine Co.

Fault Locators
Matthews Corp., W. N.

Feed Water Heaters
Bethlehem Shipbldg. Corp., Ltd.

Fence, Woven Wire
Cyclone Fence Co.

Financial
American Gas & Electric Co.
Associated Gas & Electric Co.
Electric Bond & Share Co.
Foshay, W. B.
Pynchon & Co.

Flooring, Open Steel
Blaw-Knox Co.
Irving Iron Works Co.

Flooring, Steel
Irving Iron Works Co.

Forgings, Drop Hammered and Hydraulically Pressed
Bethlehem Steel Co.

Furnace Bottoms
Furnace Engineering Co., Inc.

Furnaces, Electric
American Brown Boveri Elec. Corp.
Pittsburgh Electric Furnace Corp.
Electric Steel Melting
American Bridge Co.
Pulverized Fuel
Fuller Lehigh Co.

Furnace Walls, Water Cooled
Superheater Co.

Furnaces, Water Cooled
Furnace Engineering Co. Inc.
Power Specialty Co.

Fuse Plugs
Delta-Star Elec. Co.

Fuses
High Tension
Bowie Switch Co.
Delta-Star Elec. Co.
Electrical Engineers Equip. Co.
Hi-Voltage Equipment Co.
Johns-Pratt Co.
Line Material Co.
Matthews Corp., W. N.
Schweitzer & Conrad Co.
Westinghouse Elec. & Mfg. Co.
Refillable
Johns-Pratt Co.
Renewable
Johns-Pratt Co.
Westinghouse E. & M. Co.
Standard
Condit Elec'l Mfg. Corp.
General Electric Co.
Graybar Electric Co.
Westinghouse E. & M. Co.

Galvanizing
Hubbard & Co.

Galvanizing, Hot Dip
Bates Exp. Steel Truss Co.
Cattie & Bros., Jos. P.
Lehigh Structural Steel Co.

Gates, Head and Sluice
Smith Co., S. Morgan

Gauges, Recording
Bristol Co., The
Foxboro Co., Inc.

Guards, Lamp
Matthews Corp., W. N.

Gearing, Silent and Flexible
Link-Belt Co.

Gears
Bethlehem Steel Co.
Continental Fibre Co.
General Electric Co.
Westinghouse Elec. & Mfg. Co.
Reduction
Terry Steam Turbine Co.
Silent
Formica Insulation Co.
Worm Reduction
De Laval Steam Turbine Co.

Generators
Allis-Chalmers Mfg. Co.
American Brown Boveri Elec. Corp.
Burke Electric Co.
Ridgway Dynamo & Eng. Co.
Belt Driven
Westinghouse Elec. & Mfg. Co.
Engine Driven
Westinghouse Elec. & Mfg. Co.
Motor
American Brown Boveri Elec. Corp.
Steam
Combustion Engr. Corp.
Turbo
American Brown Boveri Elec. Corp.
Waterwheel Driven
American Brown Boveri Elec. Corp.
Westinghouse Elec. & Mfg. Co.

Generating Sets
General Electric Co.
Ridgway Dynamo & Eng. Co.
Westinghouse E. & M. Co.
Direct Connected & Geared
Westinghouse Elec. & Mfg. Co.
Motor
Allis-Chalmers Mfg. Co.
Turbine Driven
Westinghouse Elec. & Mfg. Co.

Governors
Pelton Water Wheel Co.

Governors, Water Wheel
Hydraulic
Woodward Governor Co.
Mechanical
Woodward Governor Co.

Grates, Furnace
Furnace Engineering Co., Inc.

Grating, Steel
Irving Iron Works Co.

Grounds, etc.
Copperweld Steel Co.
Paragon Electric Co.

Ground Caps
G. & W. Elec. Spec. Co.

Hangers
Cable
Hubbard & Co.

Heaters, Electric
Automatic Elec. Heater Co.

Heaters, Feed Water
Bethlehem Shipbldg. Corp.
Cochrane Corp.
Griscom-Russell Co., The

Heaters, Oil
Bethlehem Shipbldg. Corp.

Heating Devices
Cutler-Hammer Mfg. Co.
General Electric Co.
Graybar Electric Co.
Westinghouse E. & M.

Hoists
Electric
American Engr. Co.
Lipe, Inc., W. C.
Electric and Steam
Allis-Chalmers Mfg. Co.
Link-Belt Co.
Head Gate
Smith Co., S. Morgan

Indicators, Speed
(See Tachometers)

Indicators, Transformer Road
Westinghouse Elec. & Mfg. Co.

Inspections and Tests
Electrical Testing Laboratories

Instrument Transformers
General Electric Co.
Roller-Smith Co.
Weston Elec'l Inst. Co.

Instrument Test Switches
Electrical Development & Mach. Co.

Instruments
Boiler Room
Bristol Co., The
Foxboro Co., Inc.
General Electric Co.
Westinghouse E. & M. Co.
Electrical
Bristol Co., The
Jewell Elec'l Inst. Co.
Roller-Smith Co.
Sangamo Electric Co.
Graphic
Biddle, James G.
Bristol Co., The
General Electric Co.
Sangamo Electric Co.
Zernickow, O.
Indicating
Foxboro Co., Inc.
General Electric Co.
Jewell Electrical Instrument Co.
Rawson Elecl. Instr. Co.
Roller-Smith Co.
Westinghouse E. & M. Co.
Integrating
General Electric Co.
Sangamo Electric Co.
Westinghouse E. & M. Co.
Portable
Westinghouse Elec. & Mfg. Co.
Recording
Bristol Co., The
Westinghouse Elec. & Mfg. Co.
Scientific and Testing, Service
Biddle, James G.
Bristol Co., The
General Electric Co.
Leeds & Northrup Co.
Rawson Elec'l. Instr. Co.
Roller-Smith Co.
Westinghouse E. & M. Co.
Weston Elec'l Inst. Co.
Transformer
General Electric Co.

Insulating Machinery, Wire
American Ins. Machinery Co

Insulating Material
Asbestos, Ebony
Deceleco Co.
Asbestos
Johns-Manville, Inc.
Compounds, Paints and Varnishes
Formica Insulation Co.
General Electric Co.
Irvington Varnish & Ins. Co.
Westinghouse E. & M. Co.
Comp. Cloth and Paper
General Electric Co.
Irvington Varnish & Ins. Co.
Custom Molded
Johns-Pratt Co.
Fibre
Continental Fibre Co.
National Vulc. Fibre Co.
Standard Fibre Prods. Co.
Spaulding Fibre Co.
Lava
American Lava Corporation
Steward Mfg. Co., D. M.
Mica Micarta
Westinghouse Elec. & Mfg. Co.
Molded
Bakelite Corp.
Cutler-Hammer Mfg. Co.
Formica Insulation Co.
Garfield Mfg. Co.
Insulation Mfg. Co.
Johns-Manville, Inc.
Paper
Irvington Varnish & Ins. Co.
Porcelain
Mica Insulator Co.
Silk
Irvington Varnish & Ins. Co.
Slate
Portland Monson Slate Co.
Tape and Webbing
General Electric Co.
Okonite Co., The
Transite
Deceleco Co.
Treated Fabrics & Paper
Westinghouse Elec. & Mfg. Co.
Untreated Fabrics & Paper
Westinghouse Elec. & Mfg. Co.

Insulation, Electric
Bakelite Corp.
Spaulding Fibre Co., Inc.

Insulators
China, Porcelain & Composition
Illinois Elec. Porcelain Co.
Locke Ins. Corp.
Mica Insulator Co.
High Voltage Porcelain
Electric Service Supplies Co.
Lapp Insulator Co., Inc.
Glass
Hemingray Glass Co.
Lapp Insulator Co., Inc.
Porcelain and Composition
Porcelain Insulator Corp.
Porcelain, Composition
Cook Porcelain Insulator Co.
Franklin Porcelain Co.
General Electric Co.
General Porcelain Co.
Imperial Porcelain Works
Lapp Insulator Co., Inc.
Locke Ins. Corp.
Thomas & Sons Co., R.
Westinghouse Elec. & Mfg. Co.
Porcelain
Canadian Porcelain Co., Ltd.
Insulation Mfg. Co.
Ohio Brass Co.
Post Type
Delta-Star Elec. Co.
Elec'l Development & Machine Co.

Insulator Pins
Thomas & Sons Co., R.
Ohio Brass Co.

Insulator Tester and Fault Finder
Johnson, Jr., T. F.

Irons, Electric
Electrical Dev. & Mach. Co.
Westinghouse E. & M. Co.

Jacks, Pole Pulling and Straightening
Templeton Kenly Co.

Laboratories
Electrical Testing Laboratories

Laminated Phenolic Condensation Products
Bakelite Corp.
Continental Fibre Co.
Formica Insulation Co.

Lamps
Arc
General Electric Co.
Westinghouse E. & M. Co.
Cable Supporting
Matthews Corp., W. N.
Incandescent
General Electric Co.
Graybar Electric Co.
Westinghouse Elec. & Mfg. Co.
Miniature, Inc.
General Electric Co.

Lighting Equipment, Interior and Exterior
Westinghouse Elec. & Mfg. Co.

Lighting Fixtures, Industrial
Philadelphia Elec'l. Mfg. Co.

Lighting Fixtures, Outdoor
Line Material Co.

Lightning Arresters
Delta-Star Elec. Co.
Electric Power Equip. Corp.
Electric Service Supplies Co.
Electrical Engineers' Equip. Co.
General Electric Co.
Hi-Voltage Equipment Co.
Hubbard & Co.
Ry. & Industrial Eng. Co.
Schweitzer & Conrad, Inc.
Westinghouse E. & M. Co.

Line Material
Bethlehem Steel Co.
Electric Service Supplies Co.
General Electric Co.
Hubbard & Co.
Johnson, Jr., T. F.
Line Material Co.
Ohio Brass Co.
Graybar Electric Co.
Westinghouse E. & M. Co.

Linemen's Shields and Protectors
Linemen Protector Co.

Linemen's Supplies & Tools
Johnson, Jr., T. F.
Linemen Protector Co.

Locomotives, Diesel
American Brown Boveri Elec. Corp.

Locomotives, Electric
American Brown Boveri Elec. Corp.
Westinghouse Elec. & Mfg. Co.

Lubricants
Vacuum Oil Co.

Lugs
Sherman Mfg. Co., H. B.

Lumber, Creosoted Southern Pine
International Creosoting & Constr. Co.

Machinery Hoisting
American Bridge Co.

Machinery, Mining
Allis-Chalmers Mfg. Co.

Machines, Pipe Bending
American Pipe Bending Machine Co.

Machines, Welding
Westinghouse Elec. & Mfg. Co.

Magnets
Coto-Coil Co.
Cutler-Hammer Mfg. Co.
Dudlo Mfg. Co.
Electric Controller & Mfg. Co.

Magnets, Lifting
Cutler-Hammer Mfg. Co.
Electric Controller & Mfg. Co.

Meter Testers
General Electric Co.
Westinghouse E. & M. Co.

Meters
Demand
Westinghouse Elec. & Mfg. Co.
Kilovolt Amperes
Westinghouse Elec. & Mfg. Co.
Watthour
Duncan Elec. Mfg. Co.
Westinghouse Elec. & Mfg. Co.

Meters, Flow
(See Instruments, Electric and Boiler Room)

Mica
Chicago Mica Co.

Molded Insulation (See Insulation, Molded)

Molding Materials
Bakelite Corp.

Motors
Allis-Chalmers Mfg. Co.
Baldor Electric Co.
Bodine Electric Co.
Burke Elec. Co.
Century Electric Co.
Fairbanks, Morse & Co.
General Electric Co.
Graybar Electric Co.
Imperial Electric Co.
Jeannin Electric Co.
Lincoln Electric Co.
Marble-Card Elec. Co.
Master Electric Co.
Robbins & Myers Co.
Star Electric Motor Co.
Sturtevant Co., B. F.
Zobell Elec. Motors Co.
Mine
Westinghouse Elec. & Mfg. Co.
Railway
Westinghouse Elec. & Mfg. Co.
Small
Domestic Electric Co.
Westinghouse E. & M. Co.

Motor Generators
Westinghouse Elec. & Mfg. Co.

Motor Generator Sets
Burke Elec. Co.
Ridgway Dynamo & Eng. Co.

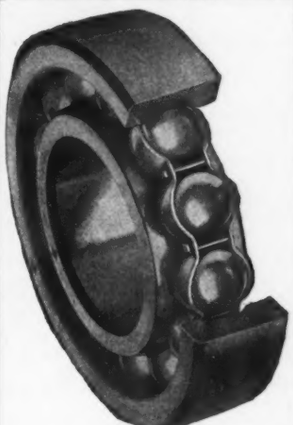
Oil and Grease, Lubricating
Vacuum Oil Co.

Oil Burners
Babcock & Wilcox Co.

Oil Burning Systems
Bethlehem Shipbldg. Corp., Ltd.

Oil Engines (See Engines)

Of course Mo-lyb-den-um increases the life-in-'em but keep this additional fact in mind—the Mo-lyb-den-um balls in an SRB Bearing are hot FORGED!

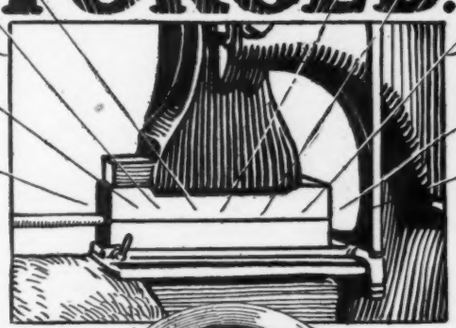


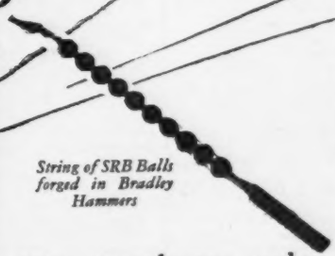
SRB Single Row Bearing Sectioned To Show Forged Mo-lyb-den-um Steel Balls

The First Complete Story of Forged Mo-lyb-den-um Steel Balls

Do you want to know why balls forged from Molybdenum Steel add at least 25% to the life of SRB Bearings? Write us for this new booklet, just off the press, "Molybdenum Means More-Life-In-'Em—Why!" It is a history of Molybdenum from the time it was first isolated in 1790 until 1925 when SRB standardized on it for ball production.

Remember Mo-lyb-den-um means More-Life-In-'Em





String of SRB Balls forged in Bradley Hammers

Molybdenum Steel increases the life of bearing balls, but experience has proven that the best results are obtained from this steel through the hot forging process. In this way the balls are formed with minimum strains and the hot-working of the steel increases the density of the grain structure, toughness and strength as well as resistance to wear and abrasion.

Therefore, do not merely order bearings equipped with Molybdenum Steel Balls but specify "SRB" with *Forged* Molybdenum Steel Balls to obtain the greatest possible benefit from this steel.

SRB

SRB Service now Includes M-R-C Thrust Bearings

STANDARD STEEL AND BEARINGS INCORPORATED

PLAINVILLE CONNECTICUT

USE SRB BALL BEARINGS—*First!* —*they'll last*

Oil Heaters
Bethlehem Shipbldg. Corp., Ltd.

Oil Separators and Purifiers
De Laval Separator Co.
Hydroil Sales Corp.
Sharples Spec. Co.

Packing, Asbestos
Johns-Manville, Inc.

Painting Equip. Mech. or Elec'l.
Matthews Corp., W. N.

Paints, Aluminum
Aluminum Co. of America

Panel Boards
General Electric Co.
Trumbull Elec. Mfg. Co

Panels, Switchboard
Allis-Chalmers Mfg. Co.
General Electric Co.

Pavement Breakers, Pneumatic
Ingersoll-Rand Co.

Parts, Molded
Belden Mfg. Co.

Penstocks
Kellogg Co., M. W.

Piling, Creosoted Southern Pine
International Creosoting & Constr. Co.

Pins, Insulator
Hubbard & Co.

Pipe
Riveted Steel
Riter-Conley Mfg. Co.

Pipe Frame Fittings, Elec'l
Schweitzer & Conrad, Inc.
Westinghouse Elec. & Mfg. Co.

Platinum
Baker Platinum Works

Plugs
Delta-Star Electric Co.
General Electric Co.
Westinghouse E. & M. Co.
Attachment
Cutler-Hammer Mfg. Co.
General Electric Co.

Pole Line Hardware
Bethlehem Steel Co.
Electric Service Sup. Co.
Graybar Electric Co.
Hubbard & Co.
Ohio Brass Co.
Westinghouse Elec. & Mfg. Co.

Poles
Cedar
Bell Lumber Co.
Carney & Co., B. J.
Graybar Electric Co.
Creosoted Southern Pine
International Creosoting & Constr. Co.
Long Bell Lumber Co.
Texas Creosoting Co.
Iron
Archbold-Brady Co.
Steel
Aermotor Co.
Archbold-Brady Co.
Bates Exp. Steel Truss Co.
Bates Steel Corp., Walter
Lehigh Structural Steel Co.
Milliken Bros. Mfg. Co.
Riter-Conley Mfg. Co.
Truscon Steel Co.
Wood
American Creosoting Co.
Hubbard & Co.

Poles, Reinforcing of
Hubbard & Co.

Posts, Creosoted Southern Pine
International Creosoting & Constr. Co.

Posts, Guard Rail Creosoted Southern Pine
Long-Bell umber Co.

Potentiometers
Biddle, James G.
General Electric Co.
Leeds & Northrup Co.
Westinghouse Elec. & Mfg. Co.

Potheads
Elec'l Development & Machine Co.
G. & W. Elec. Spec. Co.

Preheaters, Air
Air Preheater Corp.
Babcock & Wilcox Co.

Projectors, Floodlighting
Elec. Service Supplies Co.
Westinghouse Elec. & Mfg. Co.

Pullers, Car
Mead-Morrison Mfg. Co.

Pullers, Fuse Plug
G. C. A. Mfg. Co.

Pullers, Slack
Matthews Corp., W. N.

Pulleys, Paper
Rockwood Mfg. Co.

Pulverized Fuel Equipment
Aero Pulverizer Co.
American Pulverizer Co.
Combustion Engineering Co.
Fuller-Lehigh Co.
Furnace Engineering Co., Inc.
Power Specialty Co.
Riley Stoker Corp.

Pumps
Worthington Pump & Machy. Corp.
Boiler Feed
Bethlehem Shipbldg. Corp., Ltd.
Cameron Steam Pump Works, A. S.
Chicago Pump Co.
Ingersoll-Rand Co.
Lecourtenay Co.
Centrifugal
Allis-Chalmers Mfg. Co.
Bethlehem Shipbldg. Corp., Ltd.
Cameron Steam Pump Works, A. S.
Chicago Pump Co.
De Laval Steam Turbine Co.
Fairbanks, Morse & Co.
Ingersoll-Rand Co.
Lecourtenay Co.
Terry Steam Turbine Co.
Drainage and Irrigation
Cramp & Sons Ship & Eng. Bldg Co., Wm.
Pelton Water Wheel Co.
Mine Gathering
Fairbanks, Morse & Co.
Power
Lecourtenay Co.
Reciprocating
Allis-Chalmers Mfg. Co.
Bethlehem Shipbldg. Corp., Ltd.
Special
Quimby, Inc., Wm. C.
Steam
Fairbanks, Morse & Co.

Pumping Plants
Fairbanks, Morse & Co.

Pumping Systems, Air Lift
Ingersoll-Rand Co.

Pyrometers
Bristol Co., The
Leeds & Northrup Co.

Racks, Cable
G. & W. Elec. Spec. Co.

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Hubbard Co.
Truscon Steel Co.

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General Electric Co.
General Radio Co.
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Ohio Brass Co.

Ranges, Electric
Westinghouse Elec. & Mfg. Co.

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Rectifiers
General Electric Co.
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Mercury
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Iron Mountain Co.
Servel Corporation

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American Brown Boveri Elec. Corp.

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Westinghouse Elec. & Mfg. Co.

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Electric Controller & Mfg. Co.
Westinghouse Elec. & Mfg. Co.

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High Tension Elec'l Spec. Co.
Ry. & Industrial Eng. Co.

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Westinghouse Elec. & Mfg. Co.

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Superheater Co.

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Sundh Electric Co.
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Randle Mchy. Co.
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Electric Controller & Mfg. Co.

Separators, Steam and Oil
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Copper, Brass, Bronze and Nickel Silver
American Brass Co.
Metal
Bethlehem Steel Co.

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Stop and Go
Essco Mfg. Co.
Mushroom Type
Essco Mfg. Co.

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Portland Monson Slate Co.

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Memco Engr. & Mfg. Co.

Slotter, Commutator
Green Equip. Co.

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Cutler-Hammer Mfg. Co.
General Electric Co
Paulding, Inc., John I.

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Soldering Flux
Westinghouse Elec. & Mfg. Co.

Soldering Irons
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Solenoids
Electric Controller & Mfg. Co.

Solenoids (See Coils)

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Truscon Steel Co.

Standards, Street Lighting
Union Metal Mfg. Co.

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Blake Signal & Mfg. Co.

Starters, Motor, Electric
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Industrial Controller Co.
Sundh Electric Co.
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Power Specialty Co.

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Structural
Blaw-Knox Co.
Milliken Bros. Mfg. Co.

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Steps, Safety Stair
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Superheaters, Steam
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Timbers, Creosoted Southern Pine
International Creosoting & Constr. Co.

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Bristol Co., The
Foxboro Co., Inc.

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Compactness, Safety and Reliability

Allis-Chalmers Reyrolle Armorclad Switchgear

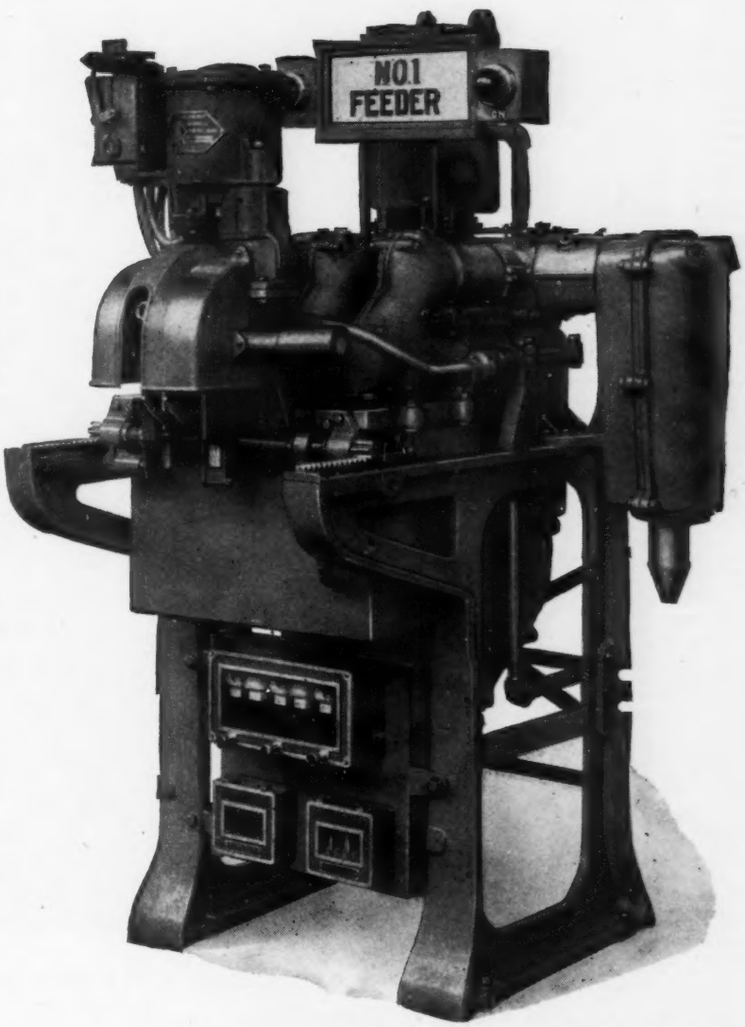
Combines in one factory built unit the busbar structure, circuit breaker, outgoing feeder connections and instrument transformers.

Relays and instruments can be mounted on unit itself, or on separate control board as local conditions dictate.

Compactness of design enables switching equipment to be installed in considerably less space than required with cell mounted breakers saving building space and frequently resulting in lower overall total installed cost.

Metal clad construction gives complete safety to operators and insures reliability in service.

Allis-Chalmers Manufacturing Company has acquired from A. Reyrolle & Company, Ltd., Hebburn-on-Tyne, England, who are responsible for the development and unusual success of this type of Switchgear in Great Britain and on the Continent, the exclusive rights for its manufacture and sale in the United States, Cuba and Mexico.



300 Amp., 15,000 Volt Electrically Operated Breaker Unit.
75,000 KV-A. Interrupting Capacity.

Leaflet 2085 will be furnished on application

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MILWAUKEE, WISCONSIN

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Short Circuit Protection

We unhesitatingly claim the U-Re-Lite to be the finest piece of electrical protection in its field today. This is a broad statement to make, admittedly, but we have certain proof.

Send for the complete data on the short circuit tests made on the U-Re-Lite by the Union Gas & Electric Company of Cincinnati, Ohio. A copy will be forwarded with our compliments.

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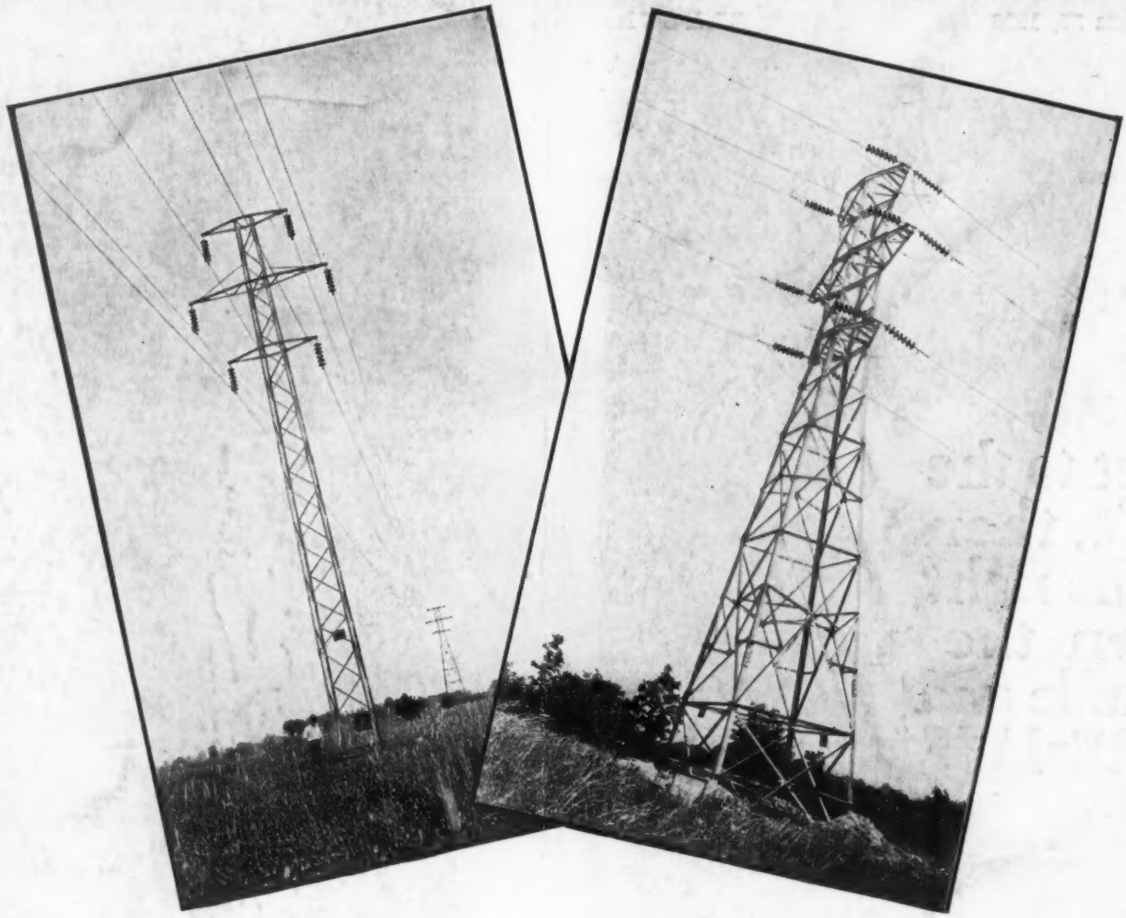
Established 1885 - Philadelphia

CUTTER

U-RE-LITE I-T-E CIRCUIT BREAKERS



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Bates Fabricated Towers will be built to your designs and specifications, or will be engineered as well by the Bates Organization. You will find Bates Towers on many important installations, meeting the requirements of the situation with perfect satisfaction.

Bates Galvanized

Bates facilities are complete. Our new galvanizing plant enables us to produce the finished structure entirely within our organization. Our estimates on your proposed tower installations will show the benefits of this.

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